AUTOMATION

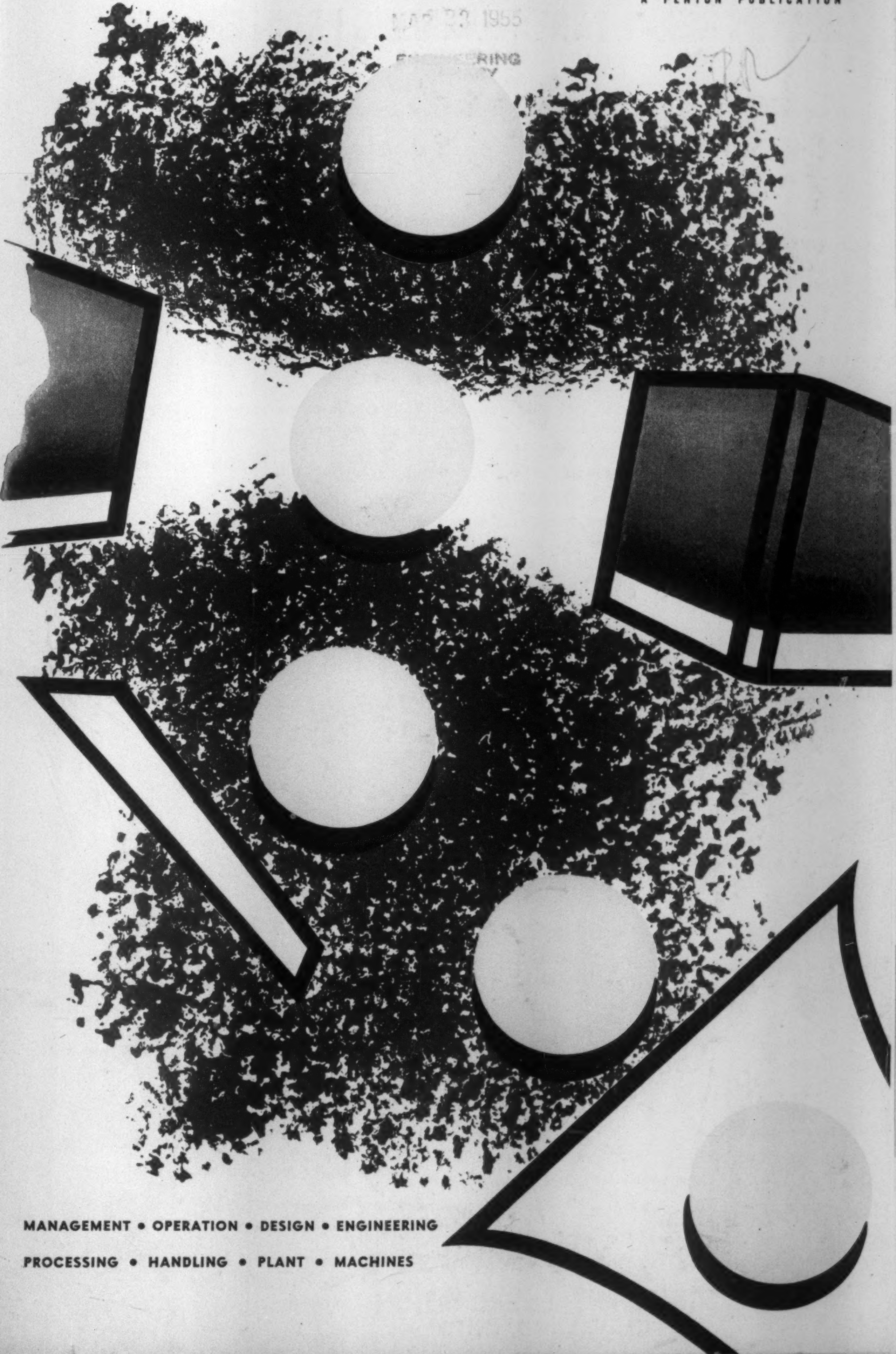
Registered U.S. Pat. Off.

UNIVERSITY
OF MICHIGAN

MAR 23 1955

ENGINEERING
LIBRARY

APRIL 1955
A PENTON PUBLICATION



MANAGEMENT • OPERATION • DESIGN • ENGINEERING

PROCESSING • HANDLING • PLANT • MACHINES

WEAN "AUTOMATED" TRANS-CAR LINE SOLVES HEAVY PARTS HANDLING PROBLEM

Unique system carries bulky sections through entire machining operation

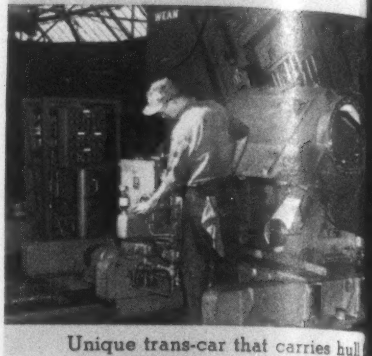
The Massey-Harris Co. is used to handling and precision working large machine components. Thus, when they accepted the contract to produce combat vehicle hulls for the Army they immediately got in touch with Wean Equipment engineers.

A team of Wean Equipment engineers working with a similar group from Massey-Harris soon vetoed the possibility of using standard machine tools on a cost basis. It was decided a complete line, especially built to do the job, was the only practical answer.

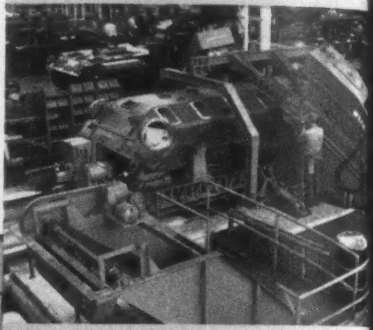
In eight months' time, Wean Equipment developed and built the now famous trans-car line. The line is composed of three stations: milling, drilling, and boring. The unusual feature is the car that operates on a set of tracks, running between stations, and eliminates all handling of the bulky, heavy hull.

If special "automated" machinery is what you're looking for, call in a Wean Equipment man today. He represents probably the widest experience in specialized machinery to be found anywhere. Like Massey-Harris, you'll find Wean the surest, most inexpensive way to soundly engineered, result-getting machinery.

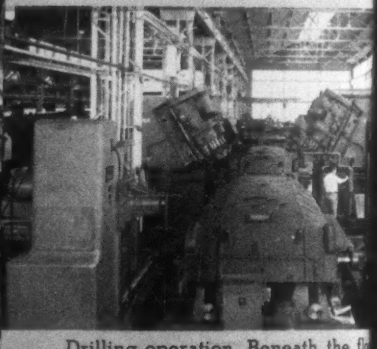
Over-all view of Wean Line that effected tremendous savings in producing giant hulls.



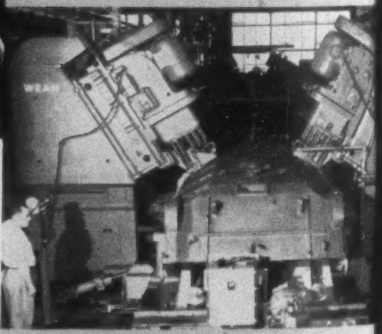
Unique trans-car that carries hull
station to station.



Milling operation. Dry cutting
carbide cutters. Air jets remove



Drilling operation. Beneath the
coolant system with magnetic
separator.



Boring operation. Drills, taps
reamers are of high speed steel.
operations are automatic.

Wean

EQUIPMENT CORPORATION
CLEVELAND, OHIO

APRIL, 1955
Vol. 2—No. 4

AUTOMATION

THE MAGAZINE OF AUTOMATIC OPERATIONS

ROGER W. BOLZ, Editor

EDITORIAL STAFF

JAMES C. KEEBLER, Associate Editor
WILBUR R. ELLIS, Associate Editor
JOHN H. McRAINEY, Assistant Editor
LEE D. MILLER, Assistant Editor
FLEUR E. WOODS, Assistant Editor
HELEN M. VERESPY, Editorial Assistant

FLOYD G. LAWRENCE, Detroit Editor

EDWARD D. KARL, Art Editor

Editorial Representative

NORMAN LYNN
Los Angeles, Webster 5-3040

REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 8
Detroit Dateline, 19
New Equipment, 70
Patents, 76
New Components, 78
New Literature, 95
Abstracts, 98
Editorial Index, 108
New Books, 110

A Natural Solution, 21
EDITORIAL—era of automation promises skilled jobs to occupy potential made available by the rising educational level.

Evaluating and Planning for Automation, 22
C. E. EVANSON—each company requires a thorough study to establish a program toward a goal of practical automation.

Steel Pipe by Continuous Welding, 31
AUTOMATION TODAY—lengths of skelp welded end to end move through furnace and tube rolling mills uninterrupted.

Machine Automates Glass Bulb Manufacturing, 34
INDEXING TURRET—equipped to assemble bulbs over stems and perform operations of fusing, exhausting, and sealing.

Assembling Small Bearings Automatically, 36
ECONOMIC REQUIREMENT—press setup feeds parts, forms shell, inspects and counts into lots for high production at low cost.

Basic Process Control, 37
C. W. WORLEY—part one—history of application of automatic control fundamentals points up evolutionary development.

Patent Problems in Automation, 43
H. A. TOULMIN, JR.—discusses revisions in the patent law in the light of the growth of automation in American industry.

Continuous Gear Production, 47
C. E. SCOTT—handling and classifying equipment adapted to various basic machines to achieve automation.

Conveyor System Automates Heat Treating, 54
INTEGRATED LAYOUT—elevates, transfers, positions and stores to encompass more than mere moving of parts.

System Controls Hydraulic Supply, 56
LIQUID LEVEL—in accumulators of high-pressure press installations controlled by differential head measurement.

Management of Systems Engineering, 58
E. D. GITTENS—part three—*How, When,* and *How Much* monitored by regular measurement and control of project status.

Machine Automates Assembly, 65
PRINTED CIRCUIT—baseboard gets electrical and electronic components inserted on 24-station trip down the line.

automation outlook

TWO BASIC TYPES OF AUTOMATION

". . . higher production, lower costs, better products and better utilization of space can result from industry's application of one or both of two basic types of automation. These are the automatic manufacture of a single product in large quantities and the manufacture of a number of different parts by a machine performing a variety of operations according to "instructions" fed into it by tapes or cards . . ."—*John J. Rudolf, supervisor of automation, Minneapolis-Honeywell Regulator Co.*

AUTOMATION OBJECTIVES

". . . automation is the application of machinery to perform and control automatically and continuously all of the manufacturing operations in a given plant—from the raw material to the finished product. It includes automatic transfer of material, automatic control and programming of operations, and automatic compilation and recording of data. Its objectives are: balanced production, uniform and controlled quality, and lower costs . . ."—*C. E. Evanson, President, T.A.B. Engineers Inc.—Page 22.*

JOBS HAVE MULTIPLIED

". . . we all know that the automobile age made things tough for the blacksmith and the buggy-whip maker. But it's also a fact that some nine-million people owe their jobs today to the invention and widespread use of the automobile. Some people have damned or ridiculed every significant improvement in the production process since the days of the early crafts. And yet jobs have multiplied much faster than machines . . ." —*R. H. Sullivan, vice president and group executive, Ford Motor Co.*

ALSO ACCESSORY EQUIPMENT

". . . the execution of what may approach the ideal of the automatic factory involves not only machine tools and other processing equipment which performs the required operations, but also the numerous types of accessory, service, power, and other equipment and, possibly, the structure which houses the entire facility . . ."—*W. F. & John Barnes Co.*

STABILIZING PRODUCTION

". . . more efficient marketing, more accurate market research and analysis will be necessary in the years ahead. A primary objective of management and one which the industrial relations man can appreciate, will be stabilizing production. Avoiding the hurry-up-and-wait of today's seasonally-based production cycles will result in cutting costs, and—a plus for industrial relations—maintaining steady employment . . ."—*Industrial Relations News.*

A DOWN-TO-EARTH METHOD

". . . the market for instrumentation and automation is far from saturated, primarily because as a down-to-earth method of increasing efficiency it still doesn't get as much attention, at top levels of management, as it deserves. Much in the way of improvement is available now. More will certainly be available as the many kinds of equipment needed for automation are developed and perfected. Many a process or machine or series of operations can be made more automatic than it is now, with the resulting benefits of better product, less scrap loss, greater productivity or efficiency with less effort from the worker—all of which add up to lower costs . . ."—*Henry F. Dever, President, Brown Instruments Div., Minneapolis-Honeywell Regulator Co.*

BALANCED BY NEW JOBS

". . . the lamp industry has been a leader in technological improvements, or automation, throughout its 75-year history. This has resulted in increasing employment over the years because it has improved the quality and reduced the cost of our products. At the same time there has been very little temporary loss of jobs because of technological improvements. We believe that any employment problems resulting from more efficient use of machinery in 1955 will be balanced by jobs resulting from our expected increases in business . . ."—*Donald L. Millham, vice president and general manager, Lamp Div., General Electric.*

AUTOMATION

Penton Building, Cleveland 13, Ohio
Main 1-8260

EDWARD S. LAWSON
Business Manager

BUSINESS STAFF

Elizabeth Root, *Advertising Service Manage*

J. M. Castiglione, *Production Manager*

George J. Auner, *Statistician*

Advertising Representatives

New York 17 ....60 East 42nd St.
Robert G. Macbeth
Fred A. Stanley
Murray Hill 2-2581

Cleveland 13 ....Penton Building
Larry D. Brennan
Gordon W. Rosencrans, Jr.
Main 1-8260

Chicago 11 ....520 North Michigan Ave.
Richard K. Lotz
Richard W. Jones
Whitehall 4-1234

Los Angeles 57 ....2330 West Third St.
The Robert W. Walker Co.
Dunkirk 7-4388

San Francisco 4 ....57 Post St.
The Robert W. Walker Co.
Sutter 1-5568

Griffin, Ga. ....331 South Twelfth St.
Fred J. Allen
Griffin 7854

Circulation

Jack C. Gernhard, *Manager*

Amy Lombardo, *Directory & List Dept.*

Published by

THE PENTON PUBLISHING COMPANY

G. O. HAYS ....*President and Treasurer*
R. C. JAENKE ....*Executive Vice President*
F. G. STEINEBACH ......*Vice Pres. and Secretary*
F. O. RICE ....*Vice President*
J. P. LIPKA ....*Asst. Secy. and Asst. Treas.*

Also Publisher of
STEEL • FOUNDRY • MACHINE DESIGN
NEW EQUIPMENT DIGEST

Published monthly. Subscription in the United States, possessions, and Canada: One year $10. Single copies, $1.00. Other countries one year, $20.

Copyright 1955 by The Penton Publishing Company.

Accepted as Controlled Circulation Publication at Cleveland, Ohio.

Twenty-one years ago . . .

'Way back in 1934, The Bristol Company led the way in the field of automation by developing the Bristol Systems of Coordinated Process Control.

These systems automatically controlled and coordinated all of the variables and operations of a process—such as the time of operation of valves, pumps, blowers, dampers, and the control, at a definite value or according to a time program, of variables that affected the uniformity, quality, cost, and yield of a product – such as temperature, pressure, liquid level, flow, pH, humidity, and speed.

RESULTS: They eliminated variations in processing that caused inefficiency – cut down rejections and waste – insured product uniformity – helped cut processing time as much as from 10 days to less than 30 minutes. And these systems quickly paid for themselves.

A REVOLUTIONARY CONCEPT: They brought automatic plant operation to a startling reality and were hailed at the time as a fundamentally new development – which would in time revolutionize manufacturing.

Today, Bristol Coordinated Control Systems are used in the chemical, oil refining, rubber, tobacco, textile, steel, metal working, food, paper, the automotive industries, and many others. They are so completely automatic that it is only necessary to push a button to start up, another to shut down.

The modern solution to processing and manufacturing control problems

Bristol's System of Coordinated Process Control is made possible only by the following unique combination of facilities, which have been developed during 66 years of building and applying thousands of automatic control systems and instruments in practically all industries:

1. The complete line of modern Bristol Automatic, Controlling, Recording, Electronic, and Telemetering Instruments, representing some of the most advanced ideas in instrument engineering.
2. Bristol's Fully-Automatic Time-Cycle Controllers or "Mechanical Brains".
3. Bristol's ability to combine electronics and the mechanical phases of automation.
4. The ability and facilities of Bristol's engineering staff, gained by long experience and Bristol's pioneering work in the field of automation.

Bristol Application Engineering is at your service:

Our application and field engineers are ready to solve control problems involving automation and Coordinated Process Control Systems by working jointly with your research, development, and plant engineers.

Have you an automation problem?

Our application engineers and nation-wide group of field engineers would like an opportunity to work with your technical staff on any problems of automation for which Bristol Controlling and Recording Equipment and Bristol Coordinated Control Systems appear to be the solution.

5.3

BRISTOL PRODUCTS:

Automatic Controlling, Recording, and Telemetering Instruments for:

Pressure, Vacuum, Absolute Pressure, Draft, Differential Pressure, and Barometric Pressure.

Temperature (Thermometers, Potentiometers and Pyrometers).

Flow, Water and Liquid Level, and Specific Gravity.

pH and Conductivity.

Speed of Travel and Rotation.

Humidity.

Voltage, Current, Power, and Load Totalization.

Mechanical Motion, Position and Operations

Including:

Automatic Control Systems
Electronic Potentiometers
Graphic Panel Instruments
Time-Cycle Controllers
Time-Program Controllers
Pneumatic and Electric Controllers
Instrument Panels
Control Valves

Write to The Bristol Company, 138 Bristol Road, Waterbury 20, Conn.

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE

BRISTOL

POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

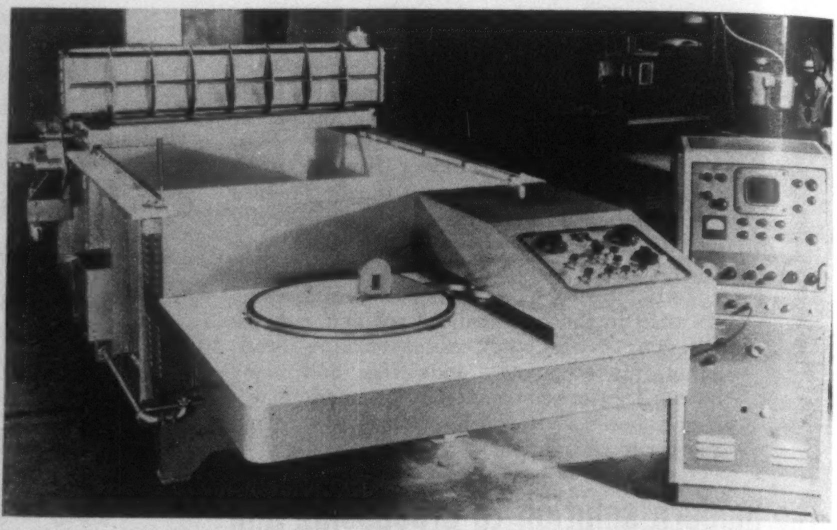
AUTOMATION news

Today's events and developments in the field of automation

Further Improvements In Ultrasonic Testing

PRODUCTION MODELS of new, sensitive ultrasonic equipment for nondestructive testing of materials, machines and components have been introduced by Sperry Products, Inc. The new UW reflectoscope is the first of its type equipped with nine frequency ranges, between 200 kc and 25 mc, and both aural and visual signals. Designed for production ultrasonic inspection, either contact or immersed, the instrument incorporates a pulse rate variable from 60 to 1000 pulses per second. High-repetition rate provides greater brilliance and faster automatic scanning speeds. This unit is capable of testing through as much as 125 feet of material and for finding tiny invisible defects as close as 0.05 inch to the surface. Instrument is built for quality control, maintenance and safety inspection operations in steel mills, forge shops, foundries and plants manufacturing aircraft and other complex fabricated products. It is equipped for one or two search unit operations with cables facilitating use at distances up to 50 feet. Defects in materials, machinery or parts are indicated automatically by visual presentation on cathode ray tube, signal lamp on the control panel of the Reflectoscope console or elsewhere by light, bell or buzzer. Connectors are provided for the use of pen recorders or devices to automatically stop machine should defects be encountered.

New Simac-Westinghouse immersed inspection tank with recorder and reflectoscope is a second installation recently introduced, (see AUTOMATION, Oct. 1954). It is used for manual and semiautomatic inspection of wheel-shaped jet engine forgings.



NEW Simac-Westinghouse immersed inspection tank with recorder and Sperry reflectoscope are designed for manual and semiautomatic inspection of wheel shaped jet engine forgings. Reflectoscope at right incorporates latest advances in ultrasonic testing apparatus including automatic visual and aural signal and recording devices.

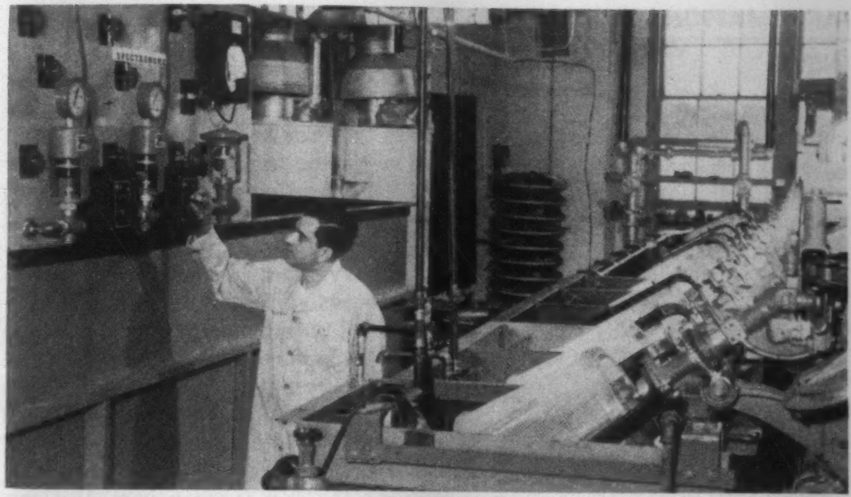
Immersion testing permits use of higher testing frequencies with improved performance in locating small defects, those lying closely together, and defects near test surface. Test piece is immersed in suitable fluid such as oil or water. Sound is "beamed" through the fluid from a universal search unit, entering test piece at any angle best suited to the shape of the part. This type of equipment is ideally suited for inspection of irregularly shaped pieces.

Operator error in observing and analyzing signals of the reflectoscope can be minimized by use of new signalling and recording attachment. Previously, operator was required to give constant attention to cathode ray screen. The new attachment actuates an alarm relay if echo signal exceeds some predetermined amplitude. This reduces ultrasonic inspection to a nontechnical routine and recording operation.

In testing raw materials in advance of processing, instruments prevent loss of time, labor and expense involved in producing finished products which, being defective, must be discarded. Ultrasonic tests are used also to check machine and product components during manufacturing operations and for preventive maintenance and safety inspection of machinery in use. Substantial savings accrue from the possibility of avoiding machine disassembly. Other current uses include examination of highly stressed parts, inspection of raw material in billet form and checking machine parts subject to fatigue failure.

Engineeringese Translated

THOSE PERSONS whose "knowledge of automatic control is largely limited to the setting of the thermostat in the living room wall" will appreciate the efforts of Brown Instrument Div. of Minneapolis-Honeywell Regulator Co. in issuing a small automation dictionary. Originally directed to the nontechnical public, booklet has been found in many an engineer's desk. Sample definition — optimalization (*optimm-al-eye-say-shun*) — The approach to economically perfect plant operation accomplished, primarily, by analytical rather than hit-or-miss methods.



REDUCED WATER CONSUMPTION with increased plating quality has resulted from installation of an automatic rinse tank controller developed by Industrial Instruments Inc. in an electroplating plant. Water savings which an installation of this type can effect are frequently more than 50 per cent. Controller operates by continuous measurement of electrolytic conductivity of rinsing water and automatic control of amount of fresh water admitted into rinse tank to establish a predetermined level of conductivity. Savings result from maximum utilization of any given quantity of water.

Improved Quality and Versatility Justifies Cost

MODERN AUTOMATIC paper sensitizing machine has been put into operation at the Chicago plant of the Charles Bruning Co. Inc. The firm manufactures sensitized coated papers and Copyflex copying machines, and is a large supplier of engineering and drafting equipment.

One hundred thousand dollars has been invested in the new high speed giant, which was designed in its entirety by the company's own engineering staff. The investment is more than justified, according to **Herbert F. Bruning,** president, by faster speeds and new high levels of quality control and uniformity maintained in all production phases by the latest electronic drives and many design innovations.

Sensitizing solution is precision metered by means of a specially designed air knife which insures a smoother, more even application free of coating cockle. An unusual degree of flatness and smoothness is secured by equipoise tension on the paper's travel through the machine, and adjustable balanced drying of both sides of the sheet, with predetermined curl control. Additional advantages of the machine are production versatility, resulting in faster delivery to customers; and large economies on scrap wastage due to the improved uniform-quality control.

Reactor Co-op for Private Industry

FIRST NUCLEAR REACTOR to be owned and operated by private industry will be built by American Machine & Foundry Co. Leading industrial concerns have been invited to participate in the program on a co-operative basis. Individual companies will be represented on a board of directors which will establish policy for the operation of the reactor facility. It is expected that participating companies will be from the electronic, petroleum, food, pharmaceutical, chemical, ceramics, rubber, metals, textile, agriculture and machinery industries. In announcing the proposed program, **General Walter Bedell Smith,** vice chairman of AMF Board of Directors said ". . . We envision the development of many new and important commercial products and the improvement and extension of a number of industrial processes."

Confidential experimentation of the participating companies is expected to further develop presently known application in sterilization and preservation of food and agricultural products, in processing

PRACTICAL APPLICATION of automation is a topic of increasing concern to business executives. A recent manufacturing orientation seminar sponsored by the American Management Association reflects this advanced interest. Orientation seminars of AMA are conducted by qualified leaders in management ranks for purpose of instructing other interested executives in the principle and theory in a given field as it is related to actual practice. The AMA discussions of the practical application of automation were conducted, with John Diebold, editor and associate publisher, *Automatic Control* as Chairman, by Albert Sperry, president, Panellit Inc.; Curtis Hillyer, president, Hillyer Instrument Co. Inc.; John Lazur, special projects co-ordinator, Arma Corp.; Evan A. Edwards, Kodak Park Works, Eastman Kodak Co., Roger W. Bolz, editor, AUTOMATION, and Robert Collins, New Departure Div., General Motors Corp. Mr. Bolz outlined the different ways in which various industries have organized internal automation programs. His talk emphasized the broad horizontal nature of automation both functionally and industrially, and the need for a wholly new approach to internal planning and organization for effective automation.

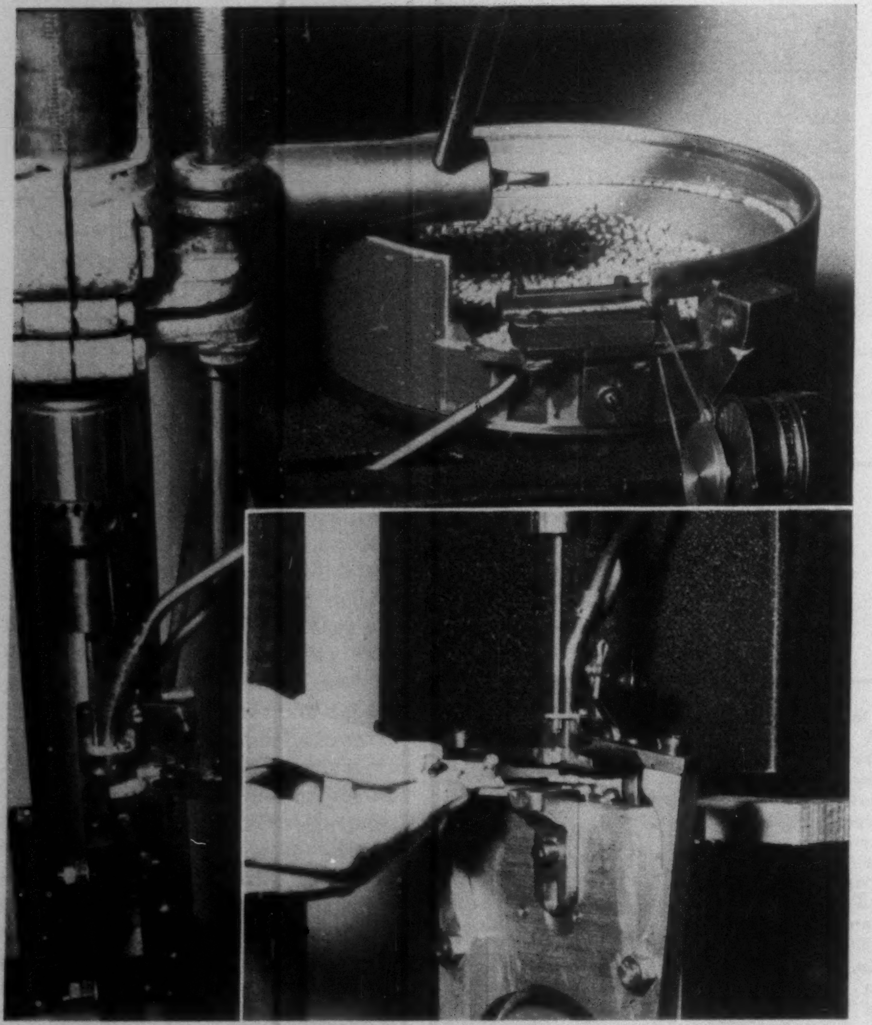
of drugs and pharmaceuticals, in altering physical attributes of plastics, and in measurement and monitoring techniques used in production.

Reactor proposed for the research facility will be of a design already proved by operating experience and will have the anticipated flexibility required to conduct a wide variety of work. Design concept of unitization will permit the standardization of certain components resulting in ease of construction and prevention of early obsolescence.

Process Variables Recorded

CONVERSION of pneumatic or electric signals into tabulated digital records is possible with an automatic logger introduced by Fisher & Porter Co. Logger may be integrated with industrial instrumentation systems currently in use by industry. Measurements of critical process variables are automatically typed in individual vertical columns of a log sheet to allow for visual inspection of trends. Tape with identification digits for each variable is punched simultaneously with the log, providing data in a form convenient for further computations.

Readout, at some preset interval, may be either the accumulated totals of the variables or the averages over the preset time cycle. Emergency or upset conditions are printed in red at any time of occurrence together with pertinent associated variables if so desired. Manual initiation of a readout cycle at any time is possible. Reported accuracy for electrical inputs is ±0.15 per cent and pneumatic inputs ±0.25 per cent.



HOPPER-FED headless set screw is latest development of Set Screw & Mfg. Co. The specially designed screws are fed by vibrating hopper to a positioning roller feed device attached to the hopper; tube carries screw from hopper to application. Device provides for automatic inspection of diameters and rejection of misfits. Inset illustrates use for particular application in which manual handling of screw has been completely eliminated. Reduction in manual handling by operator not only decreases application time but improves worker morale by automating an otherwise exasperating task.

IN ANSWER to demands of the chemical, petrochemical and petroleum industries for entire systems of automatic process control equipment, Consolidated Engineering Corp. has appointed **Jack K. Walker,** an expert on chemical instrumentation, to its systems division. Appointment emphasizes awareness of increasing interest of process industries in translating information involving process measurement and analysis into a form in which it can be used for automatic control of refining and production operations. Prior to joining Consolidated Engineering in 1952, Walker served as senior physicist for Socony-Vacuum Oil Co. and chief chemist for Triplette & Barton Inc. He is a member of American Chemical Society and Alpha Chi Sigma professional society.

Technology—Beneficial to All

BENEFITS to be gained from modern materials handling methods and similar technical advances in industry were discussed by **Elmer F. Twyman,** vice president of the Yale & Towne Mfg. Co., at the Sixth National Plant Maintenance and Engineering show.

He said, in part, "The new tech-

SPEED CONTROL
FOR
AUTOMATIC PRODUCTION
WITH
INFINITE SPEED RANGE

Completely unlike any conventional variable speed drive – SPECON controls production by the action or condition of the product being processed – with minimum operator attention. Everywhere in today's high speed industrial operations – steel, textiles, rubber, plastics and paper are but a few – this new design principle substantially lowers operating costs and assures higher product quality.

SPECON can play an important part in stepping up your production efficiency, too. We'll be pleased to show you how. Write to: Speed Control Div., Fairchild Engine & Airplane Corporation, St. Augustine, Fla.

FEATURES OF SPECON

- ★ Instant automatic performance provides uniform uninterrupted speed acceleration.
- ★ Winding tension may be constant — or tapered for any desired build-up ratio.
- ★ Full torque continuously available — at low and zero speeds.
- ★ Unequalled safety and dependability with unique, positive adjustment feature.
- ★ Easy on-the-spot adjustments to meet changing production requirements.
- ★ Minimum maintenance results from standard interchangeable gears and motors.

PAPER
STEEL
WIRE
TEXTILES

ENGINE AND AIRPLANE CORPORATION
FAIRCHILD
Speed Control Division
St. Augustine, Florida

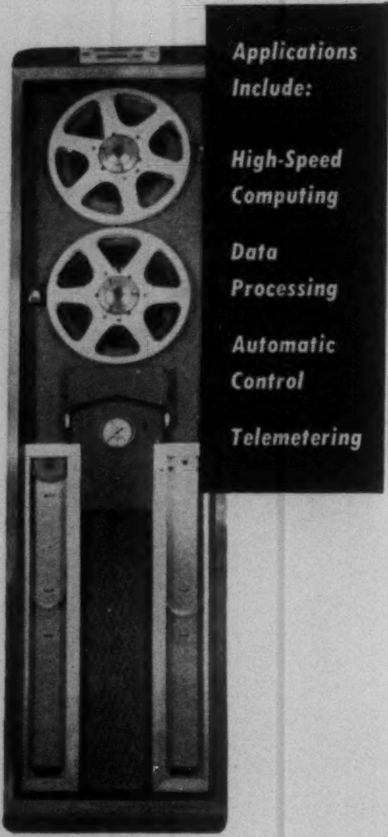
Aircraft Division, Hagerstown, Maryland • Engine Division, Farmingdale, N.Y.
Guided Missiles Division, Wyandanch, N. Y. • Stratos Division, Bay Shore, N.Y.

ElectroData Corporation announces

DataReader

Model 546

A transport unit for high speed searching, reading and recording of data on magnetic tape.



Applications Include:

High-Speed Computing

Data Processing

Automatic Control

Telemetering

PERFORMANCE:

RAPID START—STOP—REVERSE—from stop to full speed in 6 milliseconds.

HIGH TAPE SPEED—optional speed of 30, 40, 50, 60 or 75 in/sec.

TWO-DIRECTION SEARCH—either direction, automatically at full speed.

REMOTE OPERATION—forward, reverse, stop, rewind and selection of reading and writing.

VACUUM CONTROL—smooth vacuum column servo-action control.

END OF TAPE SENSING—stops automatically at either end of tape.

RAPID REWIND—2400 ft. of ½" or ¾" tape in 3 minutes.

FOR FURTHER INFORMATION WRITE

ElectroData Corporation
Component Sales Division
717 No. Lake St., Pasadena 6, Calif.

ElectroData

An Affiliate of
CONSOLIDATED ENGINEERING CORPORATION
OF PASADENA, CALIFORNIA

ElectroData Corporation maintains a nationwide sales and service organization.

nology promises our population the opportunity to work at jobs without risk of accident. It offers the American people the chance to eliminate back-breaking toil from wage earning, and in its place, to substitute work without enervating fatigue. The new technology will certainly increase productivity; but at the same time it will also make possible a vast increase in our ability to consume goods and service.

The beneficial economic consequences of such work conditions are enormous for the entire population. A healthier, less tired, more alert population, with adequate leisure, strengthened by universal education is capable of reaching the highest level of living imaginable. With the eradication of human and economic waste through technology, goods and services will be produced at lower costs, and they will be consumed in greater abundance.

As one who has had long experience with a technologically advanced industry that has developed and supplied America with productive labor-aiding machinery, I am confident the new technology will bring more and better employment and a prosperity for all, greater than we have ever known."

PURCHASE of American Microphone Co. by Elgin National Watch Co. has been announced. Purpose of acquisition is to provide opportunities for diversified growth in the commercial electronics field to balance military nature of production of Elgin-Neomatic, another recent purchase of Elgin National Watch. Both purchases are described by **J. G. Shennan,** president, as part of Elgin's planned diversification program through which the company is entering the growth fields of miniature electronic components and automatic production instruments.

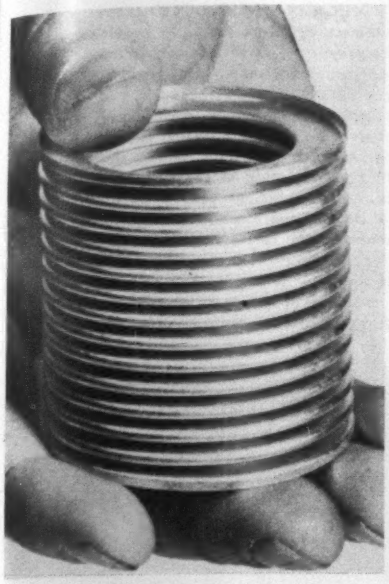
Identifies Recording Charts

COMPACT DEVICE that automatically prints a number, date or time on Brown strip chart and similar recorder charts at any instant when a voltage is applied to the device has recently been developed by Royson Engineering. The unit makes it easy for users to identify individual sections of recording charts in relation to particular conditions taking place at a remote point. It mounts on the outside of the door of the recorder regardless of type of instrument and it does not interfere with or obscure the recording procedure. Though made for 28 volts dc operation, it can be adapted to other electrical requirements. Device is supplied in kit form so that the user can easily intall the unit. The kit consists of a strip of rubber for the chart platten, mounting screws, plexiglass window to replace the original one in the door, plastic transparent cover for the device itself and instructions for installing.

SELF-SERVICE PRINCIPLE is applied to wholesaling of home furnishings by H. G. Burger, manufacturers' representative. Among other things illustrated are cards which need only purchaser and quantity information to complete typical order form for each item displayed. At the end of the display, product cards are summarized on tabulating machines and dispatched to respective manufacturers as orders.

Must Plan Now for Changes Automation Will Bring

RAPIDLY changing requirements for tool and die making, brought on by the fast strides of automation, preoccupied the thoughts of trustees of the National Tool & Die Manufacturers Association at its winter meeting. How to obtain the more accurate equipment and how to train a sufficient reservoir of highly skilled manpower

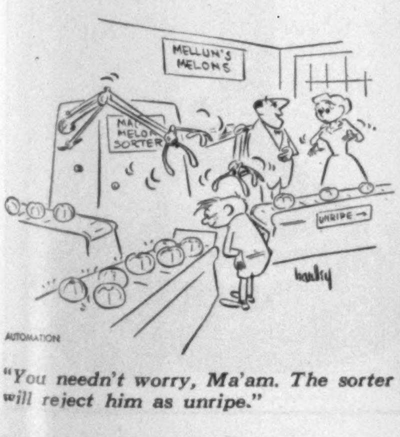


METAL BELLOWS of Robertshaw-Fulton Controls Co. recently marked their 50th anniversary in industry. Soldered brass form of earlier years has been replaced by seamless form in wide use today. In modern bellows manufacturing, tube forms are drawn from sheet. Tube diameters under 4⅜-inches are corrugated by hydraulic forming within special dies and larger tube diameters are corrugated by successively deepening and narrowing points along the tube by suitable rolls. Elastic characteristic of bellows, so important to instrument and control fields, is dependent on the cold working of the metal used in both methods of production.

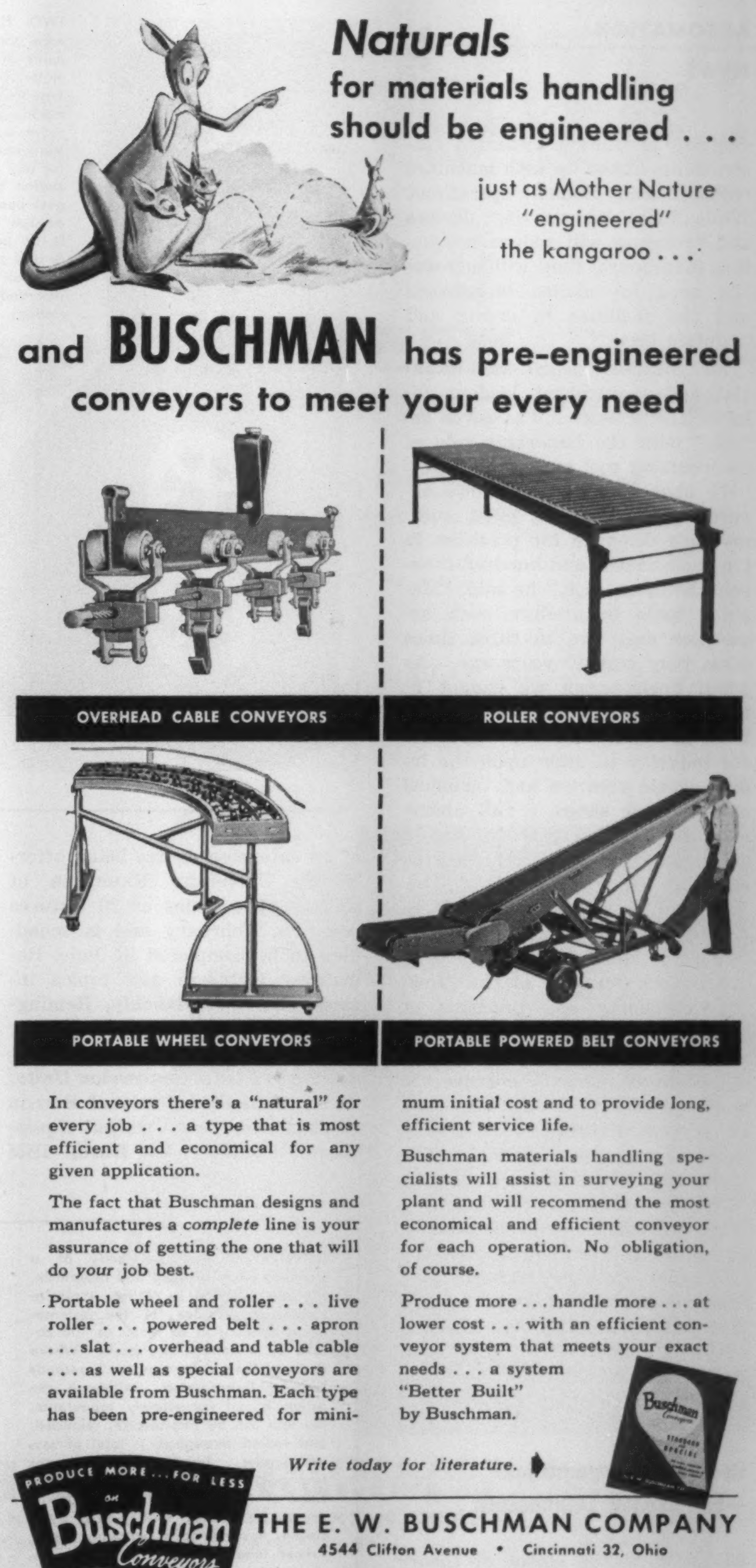
---

necessary for producing the special automation tooling loomed large in their thoughts.

Harold G. Murdock, secretary of the NTDMA and vice president of Arrowsmith Tool & Die Corp. keynoted the dual problem. "Automation, which will bring about automatic factories for many industries in the near future," he said, "poses the greatest challenge in the history of our industry. Toolmakers have been in the forefront in bringing about this second in-



"You needn't worry, Ma'am. The sorter will reject him as unripe."


Naturals
for materials handling should be engineered . . .

just as Mother Nature "engineered" the kangaroo . . .

and BUSCHMAN has pre-engineered conveyors to meet your every need

OVERHEAD CABLE CONVEYORS
ROLLER CONVEYORS
PORTABLE WHEEL CONVEYORS
PORTABLE POWERED BELT CONVEYORS

In conveyors there's a "natural" for every job . . . a type that is most efficient and economical for any given application.

The fact that Buschman designs and manufactures a *complete* line is your assurance of getting the one that will do *your* job best.

Portable wheel and roller . . . live roller . . . powered belt . . . apron . . . slat . . . overhead and table cable . . . as well as special conveyors are available from Buschman. Each type has been pre-engineered for minimum initial cost and to provide long, efficient service life.

Buschman materials handling specialists will assist in surveying your plant and will recommend the most economical and efficient conveyor for each operation. No obligation, of course.

Produce more . . . handle more . . . at lower cost . . . with an efficient conveyor system that meets your exact needs . . . a system "Better Built" by Buschman.

Write today for literature.

PRODUCE MORE . . . FOR LESS on Buschman Conveyors

C-222-EWB

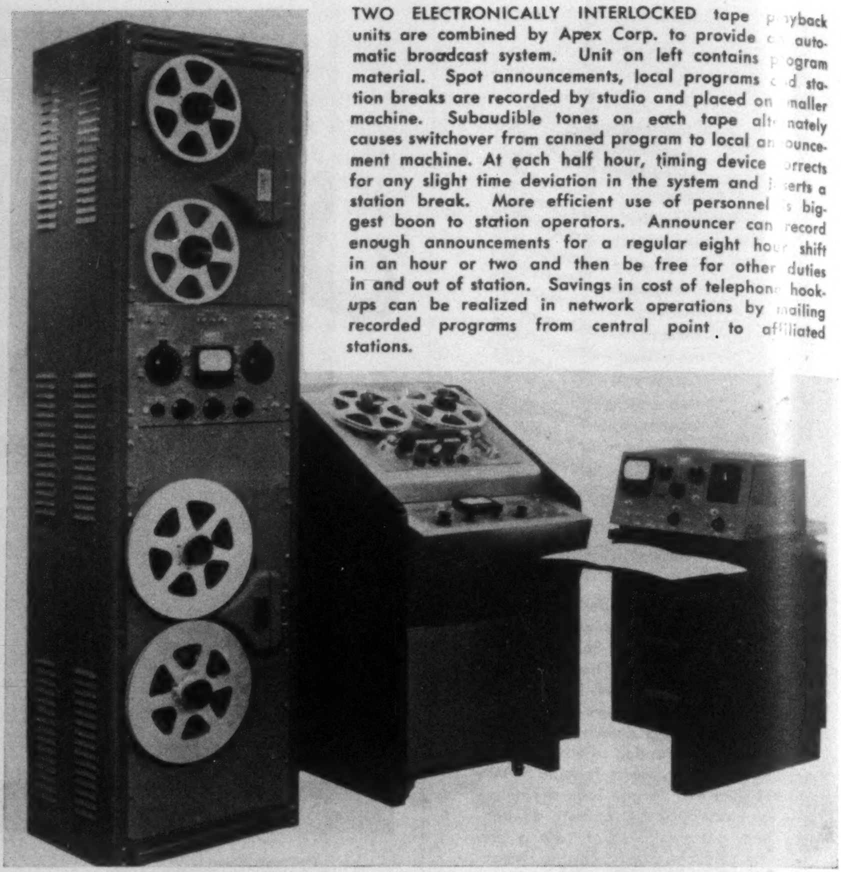
THE E. W. BUSCHMAN COMPANY
4544 Clifton Avenue • Cincinnati 32, Ohio
Representatives in Principal Cities

Complete Conveyor Systems For All Types of Industries • Engineered • Manufactured • Installed

dustrial revolution, whereby instruments linked up with machines replaced many human operations. While these labor-saving devices and processes will reduce production man-hours, they will increase the need for skilled technicians and the facilities to create and maintain them."

Mr. Murdock urged that financial and government leaders familiarize themselves, "as never before," with the important role of the contract tool and die industry. "We shop owners need more accurate equipment to meet automation's demands for precision in ten-thousandths and hundred-thousandths of an inch," he said. "Machine tools to produce such accuracies cost two to three times what they cost 10 years ago. As small businessmen we cannot finance the purchase of this equipment in the normal way. In order for industry to draw upon the indispensable creative and technical skills of our shops, a full understanding of this problem and a willingness to take the required steps are necessary."

George S. Eaton, NTDMA executive secretary, appealed to shop owners to step up the training of apprentices "in view of the growing complexity and precision of industrial processes." "While the recent slowing down in tool and die business tends to obscure the shortage of skilled men," he said, "a serious shortage does exist—and will grow more critical unless more apprentices are trained. It's a matter of simple arithmetic—more craftsmen are being promoted, retiring, dying or leaving the trade than are being trained. Just imagine the situation if a new emergency should arise. There is only one answer—every shop owner and every captive tool room should be developing new men."

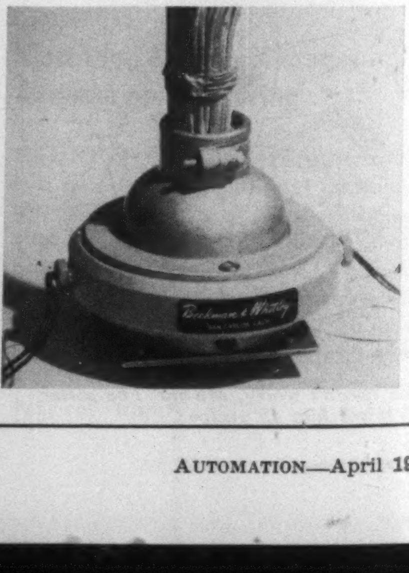


TWO ELECTRONICALLY INTERLOCKED tape playback units are combined by Apex Corp. to provide an automatic broadcast system. Unit on left contains program material. Spot announcements, local programs and station breaks are recorded by studio and placed on smaller machine. Subaudible tones on each tape alternately causes switchover from canned program to local announcement machine. At each half hour, timing device corrects for any slight time deviation in the system and inserts a station break. More efficient use of personnel is biggest boon to station operators. Announcer can record enough announcements for a regular eight hour shift in an hour or two and then be free for other duties in and out of station. Savings in cost of telephone hookups can be realized in network operations by mailing recorded programs from central point to affiliated stations.

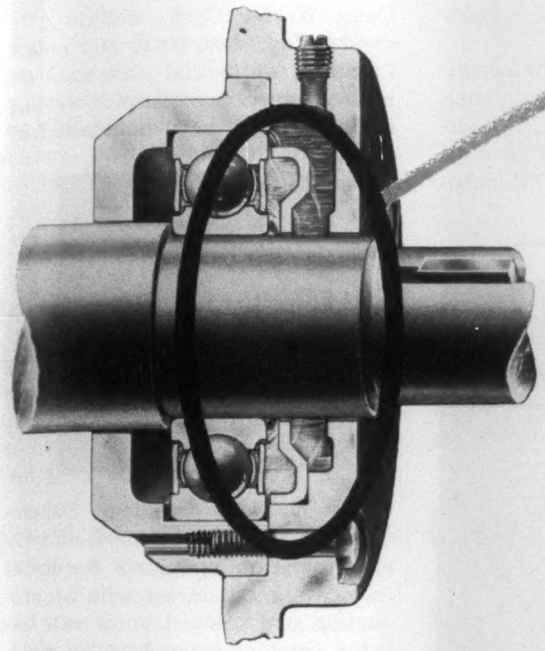
Review of Automation —Experience Emphasized

REVIEW of the status of theory and practice of automation in business and industry is the subject of an extension course being offered by University Extension of UCLA. The series of 20 lectures began in February and is scheduled to be completed in June. Remaining lecturers and topics include **John W. Mauchly,** Remington-Rand Corp., *Data Processing;* **B. S. Benson,** Benson-Lehner Corp., *Analog to Digital Conversion Units;* **S. N. Alexander,** National Bureau of Standards, *Input-Output Equipment;* **Cuthbert C. Hurd,** IBM Corp., *Data Processing Applications;* **Albert Hall,** Bendix Aviation Corp., *Automatic Control of Flight;* **L. K. Lee,** Stanford Research Institute, *Automatic Production of Electronic Equipment;* **G. C. Laspe,** Shell Oil Co., *Process Control in the Petroleum and Chemical Industries;* **E. L. Harder,** Westinghouse Electric Corp., *Analog Computers In Industrial Control Systems;* **John L. Bower,** North American Aviation Inc., *Digital Control of*

INTEGRATED with the body of a standard electrical plug and receptacle, the new Beckman & Whitley explosive disconnect provides for the instantaneous opening of as many as 100 circuits on a non-shorting basis. Where desired, time delay up to 3 seconds can be incorporated. Although the action is not immediately repeatable, the unit can be reconnected, reloaded, and reused throughout a total of several cycles. Disconnect incorporates two primers (visible at the opposite sides of the unit); when the circuits are to be opened, unit is fired by a simple, normally-open switching circuit. Primer leads can be as long as desired—minimum firing-power requirements being 1 amp at 3 volts.



RELIANCE METERMATIC



NEW METERING PLATE

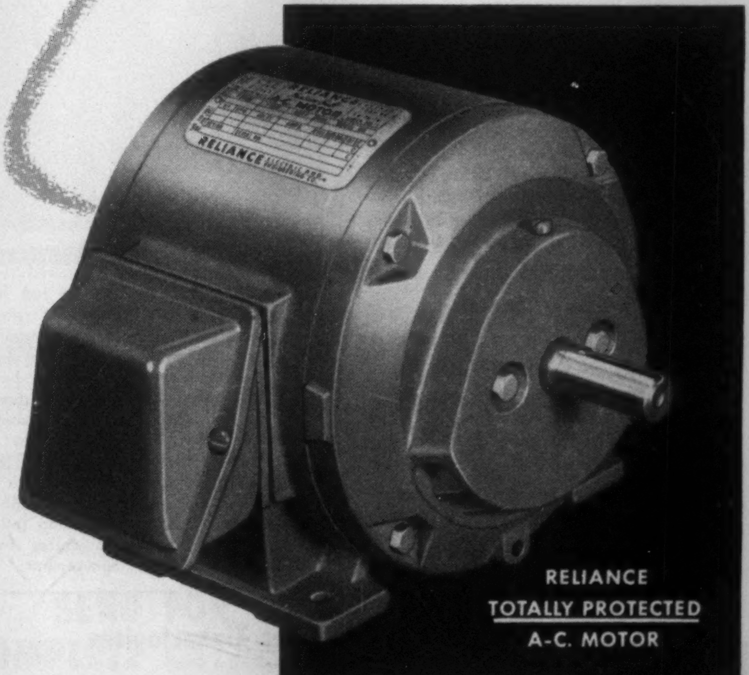
provides the right amount of lubrication for A-c. and D-c. motors

No over or under lubrication is possible . . . you *can't* grease 'em wrong!

This is your sure answer to reliable greasing to eliminate burned-out motors.

Grease is *metered* to the bearing in just the *right amount* at all times.

Get in touch with the Reliance sales office or distributor near you for more details. A-1492



RELIANCE
TOTALLY PROTECTED
A-C. MOTOR

RELIANCE "T" Super LINE

RELIANCE ELECTRIC AND ENGINEERING CO.
1128 IVANHOE ROAD • CLEVELAND 10, OHIO
Canadian Division: Welland, Ontario

Builders of the Tools of Automation

RELIANCE *Precision-Built* MOTORS

TRANSISTOR & DIGITAL COMPUTER TECHNIQUES

applied to the design, development and application of

AUTOMATIC RADAR DATA PROCESSING, TRANSMISSION AND CORRELATION IN LARGE GROUND NETWORKS

ENGINEERS & PHYSICISTS

Digital computers similar to the successful Hughes airborne fire control computers are being applied by the Ground Systems Department to the information processing and computing functions of large ground radar weapons control systems.

The application of digital and transistor techniques to the problems of large ground radar networks has created new positions at all levels in the Ground Systems Department. Engineers and physicists with experience in the fields listed, or with exceptional ability, are invited to consider joining us.

FIELDS INCLUDE

TRANSISTOR CIRCUITS
DIGITAL COMPUTING NETS
MAGNETIC DRUM AND CORE MEMORY
LOGICAL DESIGN
PROGRAMMING
VERY HIGH POWER MODULATORS AND TRANSMITTERS
INPUT AND OUTPUT DEVICES
SPECIAL DISPLAYS
MICROWAVE CIRCUITS

Scientific and Engineering Staff

HUGHES

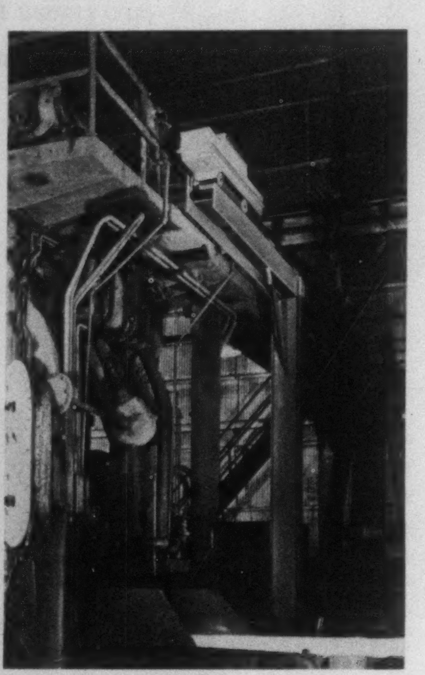
RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Machine Tools; **Roger W. Bolz,** AUTOMATION, *Manufacturing Automation;* **Frank K. Shallenberger,** Stanford University, *Plant Economies in Automation,* and **Dean E. Wooldridge,** Ramo-Wooldridge Corp., *The Future of Automation.*

Previous speakers included **Simon Ramo, Eugene M. Grabbe** (course coordinator), **John L. Barnes, Harold Chestnut, H. W. Ziebolz, Stanley Fiber** and **Willis Ware.**

These lectures have been designed to provide information for business men with a technical background who desire a preview of developments in the field of automation.

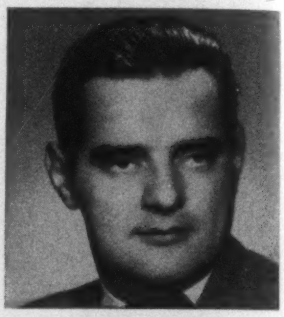


MEASURING WIDTH of red hot steel accurately as it travels at rates up to 2000 feet per minute is possible with new noncontact gage made by Industrial Gauges Corp. Gage head may be located from 10 to 20 feet above the hot metal and yet accurately measures widths from 3 inches to 10 feet. Strip temperatures of 900F to 2000F do not affect accuracy of this continuous gage. Signals are sent to the edger, speed operator and roller when width of hot strip varies from any predetermined measurement.

For Tinkertoyites

EXPERIMENTAL assemblies involving miniaturized resistors in modular or other printed circuit designs may be built and tested using precured tape resistors. A resistor manufactured by Hanson Electronics Co. alleviates the necessity of curing new resistors on a plate each time a resistor is changed. Metal terminals of this small (0.110 x 0.5-inch) item may be soldered to circuit pattern of a wafer as used in Project Tinkertoy. It is available in resistances from 39 ohms to 4.7 megohms.

FORMATION of a new company, Delta Welder Corp., dedicated to engineering, designing, and manufacturing of special and standard high production resistance welding machinery has been announced by **Harry E. Day,** president. Supplementary to the specialized activity in automation equipment for metal fabricating industries will be production of standard units and fixtures common to resistance welding field. Day, formerly vice president and general manager of Link Welder Corp., announced the appointment of **Glenn Cashdollar** as vice president and **Arthur Zebedee** as secretary-treasurer of the new firm.



MEETINGS AND EVENTS

April 4-5—

American Institute of Electrical Engineers. General Industry Applications Committee sponsored conference on automation in rubber and plastic industries to be held Mayflower Hotel, Akron, Ohio. Additional information may be obtained from society headquarters 33 West 39th St., New York 18, N. Y.

April 13-15—

American Society of Lubrication Engineers. Tenth annual meeting and exhibition to be held Hotel Sherman, Chicago. Additional information may be obtained from W. P. Youngclous Jr., 84 E. Randolph St., Chicago 1, Ill.

April 16-17—

Packaging Machinery Manufacture Institute. Spring meeting to be held Palmer House, Chicago. Additional information may be obtained from society headquarters, 322 Madison Ave., New York 17, N. Y.

April 18-21—

American Management Association. Packaging conference and exposition to be held Palmer House and International Amphitheater, Chicago. Additional information may be obtained from society headquarters, 330 W. 42nd St., New York 36, N. Y.

April 18-21—

American Society of Mechanical Engineers. Spring meeting to be held Lord Baltimore Hotel, Baltimore. Additional information may be obtained from C. E. Davies, 29 West 39th St., New York 18, N. Y.

MAY 12-13—

Michigan State College. Symposium on automation sponsored by and to be held at School of Engineering, East Lansing, Mich. Additional information may be obtained from Prof. James M. Apple, Michigan State College, East Lansing, Mich.

May 16-20—

American Material Handling Society. Meeting and exposition to be held International Amphitheater, Chicago. Additional information may be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

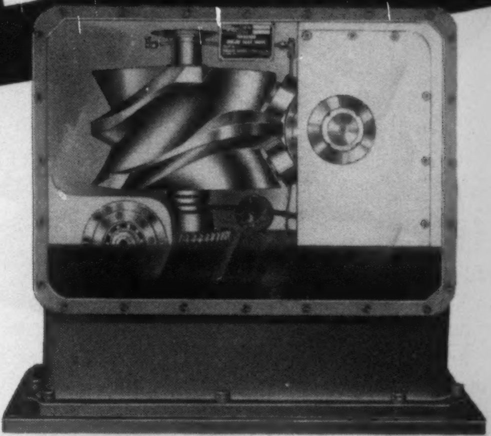
May 18-20—

National Telemetering Conference. Meeting to be held Morrison Hotel, Chicago. Additional information may be obtained from Kipling Adams, 920 S. Michigan Ave., Chicago, Ill.

June 7-10—

American Welding Society. National spring meeting and exposition to be held Hotel Muehlebach and Municipal Auditorium, Kansas City, Mo. Additional information may be obtained from society headquarters, 33 W. 39th St., New York, N. Y.

HIGH SPEED INDEXING



80% INCREASE IN PRODUCTION
with the Ferguson ROLLER GEAR DRIVE

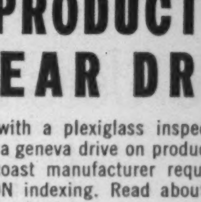
This housed Ferguson Drive with a plexiglass inspection plate was designed to replace a geneva drive on production machinery used by a west coast manufacturer requiring smooth, high speed PRECISION indexing. Read about the performance of this indexing mechanism . . .

" . . . the operation to date has completely fulfilled our expectations. Even at top speed the machine is remarkably *free from vibration,* and indexing of the conveyor is *very smooth and accurate.* We have been able to handle one type of ware at *90 per minute with better results than at 50 per minute with the geneva drive.* It certainly looks as if the Roller Gear is the solution of our problem with the conveyor drive for this machine."

TREMENDOUS MARKETING ADVANTAGES

★ *Improve Product Quality!*
★ *Increase Production!*
★ *Design Into New or Existing Equipment!*
★ *Replace Geneva Drives and Other Indexing Devices!*

SEND FOR COMPLETE CATALOG OF STANDARD DRIVES

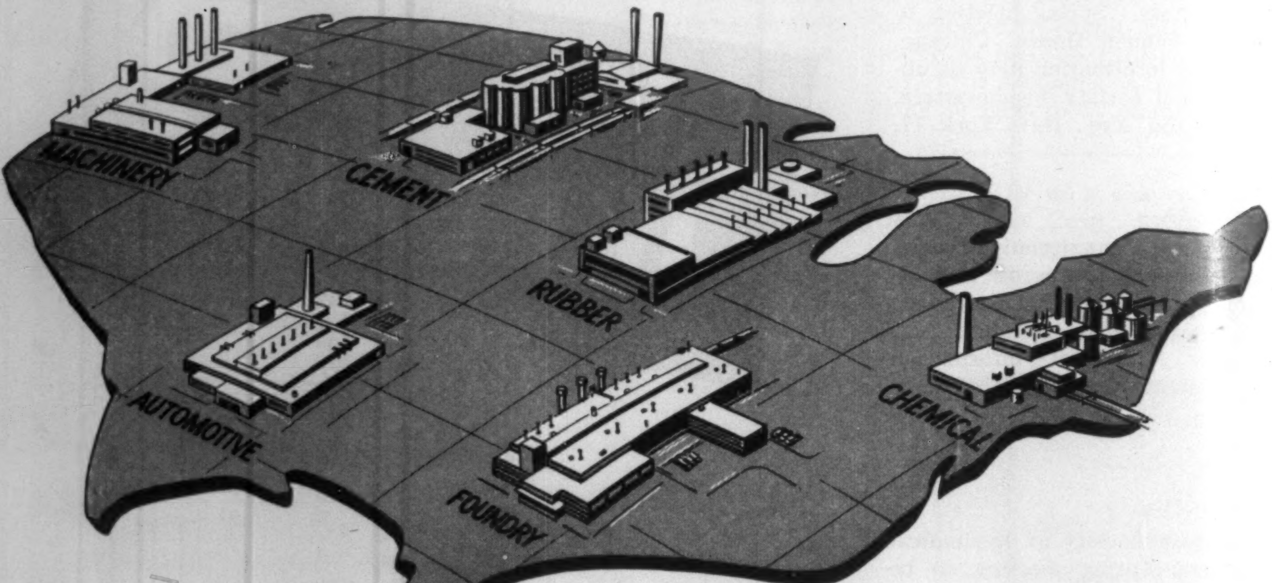


Manufacturers of the Ferguson Trans-o-Mator, Ferguson Roller Gear Drives, Dial Feed Index Tables, Roll Feeds for Presses, Special Cams, Special Purpose Machinery.

ferguson

FERGUSON MACHINE & TOOL CO., INC.

ROLLER GEAR DIVISION, DEPT. A-3, P. O. BOX 191, ST. LOUIS 21, MO.



Who Uses Professional Engineering Services?

Manufacturers, large and small—in all fields of industry, are turning to professional engineering for better manufacturing methods, better processing facilities, and to increase output and lower production costs. For more than thirty years Giffels & Vallet Inc. has provided a comprehensive planning and engineering service to a widely diversified group of industries. This flexible service can be used to plan and engineer a complete industrial installation, or to supplement and work in cooperation with the client's engineering department.

Whether it's a complete new plant, or the modernization of present facilities — automated machinery, materials handling equipment, equipment design, or process development—Giffels & Vallet Inc. offers a complete professional service to meet the specific requirements of each individual client. These services are set forth in a special Planning Brochure. A copy will be mailed on request.

Engineers and Architects serving Industry for over 30 Years

INDUSTRIAL ENGINEERING DIVISION

NEW YORK
CHICAGO
HOUSTON
WINDSOR, ONT.

Giffels & Vallet INC.

DETROIT, MICHIGAN

DETROIT DATELINE

By **FLOYD G. LAWRENCE,** Detroit Editor

BANKING FEEDS AUTOMATION

SEGMENTED AUTOMATION, the planned banking of parts between basic automated units—will probably take its place in the lexicon of modern manufacturing. Coined by Chevrolet general manager T. H. Keating, segmented automation stands in partial opposition to the fundamental automation concept of many machines joined together as one through materials handling devices. On the other hand, so long as all machines in the line are running, the flow between machines is innocuously automatic and the segmented feature appears but a nuance of meaning.

Where segmented automation comes into its own is in the fact that you can't keep all of the spindles running all of the time. Thanks to banks between segments and provision of space and handling equipment to feed from the banks, only the affected segment goes down. Other machines continue to build up the bank before the down machine while machines after it draw from the bank it has built up to supply them in such a situation.

It might be pointed out that deliberate building of the banks is not contemplated, the normal down time of the machines themselves being called upon to do this job. Turnover of the banks in thirty days is planned, however, to avoid corrosion problems in the stored material. Electric hoists are provided at each bank for stacking and feeding.

The segmented automation of Chevrolet's new V-8 engine plant in Flint is an interesting continuation of the Chevrolet philosophy of plenty of duplicate capacity to keep that voracious assembly line filled. The six-cylinder engine plant utilized banks of parts feeding groups of duplicate machines performing individual operations. The new V-8 automation segments combine previously individual operations into clusters, but each cluster is still thought of much as an individual machine.

Not only can any segment go down without stopping the flow of the line, but the provision of storage space between segments means that more stations can be added to a given segment without uprooting the entire line to make room. Inspection stations can be added where desired without displacement of machines. And, in the tryout stages of the plant, diversion routings by roller conveyor to alternative stand-by standard equipment makes possible production while bugs are ironed out in automated equipment. Even in its final form with four U-shaped engine block lines each over 1100 feet in length, these parallel facilities can be coupled at any given point in the event of serious breakdown or machinery replacement.

As to the lines themselves, each consists of nine "segments" or basic automation machines with a bank between each one. There are 121 stations on the line to take care of the block and 550 spindles work on each block in its trip through. Rollover fixtures to dump chips are frequently used and chip conveyorization is employed throughout. All transfer machines have full hydraulic operation and all stations preceding tapping operations are provided with automatic depth - gaging probes to check blind holes and avoid tap breakage.

Other portions of the Chevrolet plant have automation as well. For example, there are two machines that process intake manifolds. One does only manifolds for two-barrel carburetors. The second takes either two or four-barrel manifolds. The change is made by merely turning an electric switch on the control panel to cut in five additional stations for the four-barrel job and cut out certain two-barrel stations. Probes check to be sure the manifolds being fed into the machine are the type for which the machine is set to preclude tool breakage and shut down the machine if an improper manifold is entering.

Automation doesn't stop where engine assembly starts. After the reciprocating parts have been installed in the engine on the waist-high conveyor, the units are lifted off and transported by power and free conveyor to a battery of balancing machines. Adjusting the indicated imbalance to "zero" on the scales presets the drills to remove the correct amount for proper balance. While still on the conveyor mount the engine is returned to the line for completion of assembly.

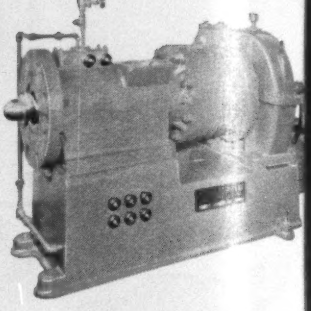
Perhaps the outstanding characteristic of the Chevrolet engine plant lies in the avoidance of "gimmicks" and the fantastic, but often unreliable, in automation. The Chevrolet philosophy has always been to keep parts coming to the assembly line. Whether you call it "segmented automation" or "pessimistic automation", there's little doubt that the new assembly line will be kept filled by the setup.

RUBBER and PLASTIC *machinery*

Builders of National Erie Line

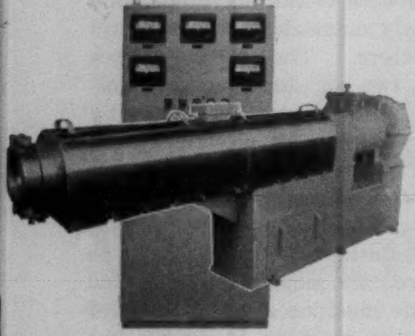
The combination of H & K and Aetna-Standard offers a complete service to the rubber and plastic industries. Builders of the National Erie line of machinery, H & K and Aetna make all types of equipment. Sales and engineering are the responsibility of Hale & Kullgren, Akron, Ohio. Aetna manufactures the equipment in their Warren, Ohio, plant.

EXTRUDERS and STRAIN
FOR RUBBER



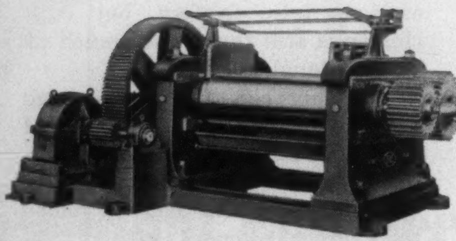
Standard sizes 2½ through 12". Illustrated—8" size fo tire treads.

EXTRUDERS FOR PLASTICS



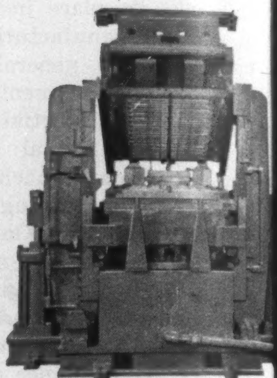
Sizes: 1½", 2½", 3½", 4½", 6", 8" and 10". Illustrated—4½" with devolatilizing section and heat control panel.

MILLS



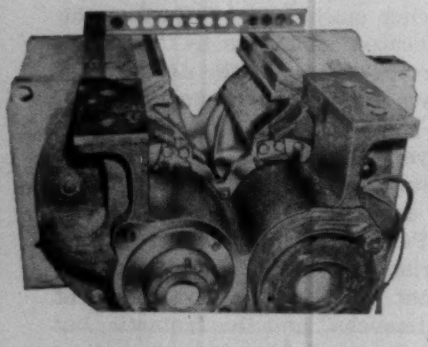
Sizes from 6" x 12" through 26" x 84". Automatic or Standard types.

PRESSES



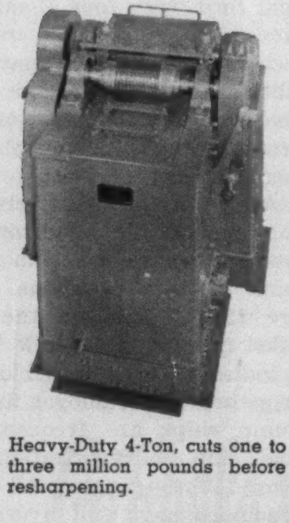
Tilting Head (illustrated); Pla Side and Rod Type with a standard platen sizes.

BANBURY REPAIR SERVICE



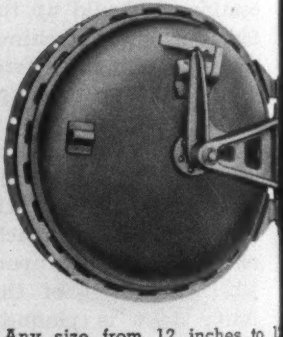
Standard Parts, Swap Service or Rebuilding Service.

CUBERS



Heavy-Duty 4-Ton, cuts one to three million pounds before resharpening.

SIMPLEX DOORS



Any size from 12 inches to 1 feet, pressures up to 400 pounds also for vacuum. Designs fo special applications.

Send your inquiry to:

HALE and KULLGREN, Inc.
613 E. Tallmadge Ave., Akron, Ohio
or Phone FRanklin 6-7161. Prompt quotations.

Sales and Engineering by
HALE and KULLGREN, INC.
P. O. Box 1231 · AKRON, OHIO

MANUFACTURED BY
THE AETNA-STANDARD ENGINEERING CO., PITTSBURGH, PA.
PLANTS IN WARREN, OHIO · ELLWOOD CITY, PA

A Natural Solution

Along with the tremendous rise in population of recent years there has been another significant trend of note to those interested in the overall character of automation. This trend is the continuously rising educational level. Since 1940 there has been an 80 per cent increase in the number of high school graduates in our population.

Among the multitude of effects and countereffects which will of necessity enter the picture this is an important one which cannot be overlooked. The gradual upgrading of jobs as a result of automation develops a natural solution to the problem of this growing educational level. Professors Baldwin and Shultz of the industrial relations section at MIT in a recent paper, presented at the Industrial Relations Research Association meeting in Detroit, comment pointedly:

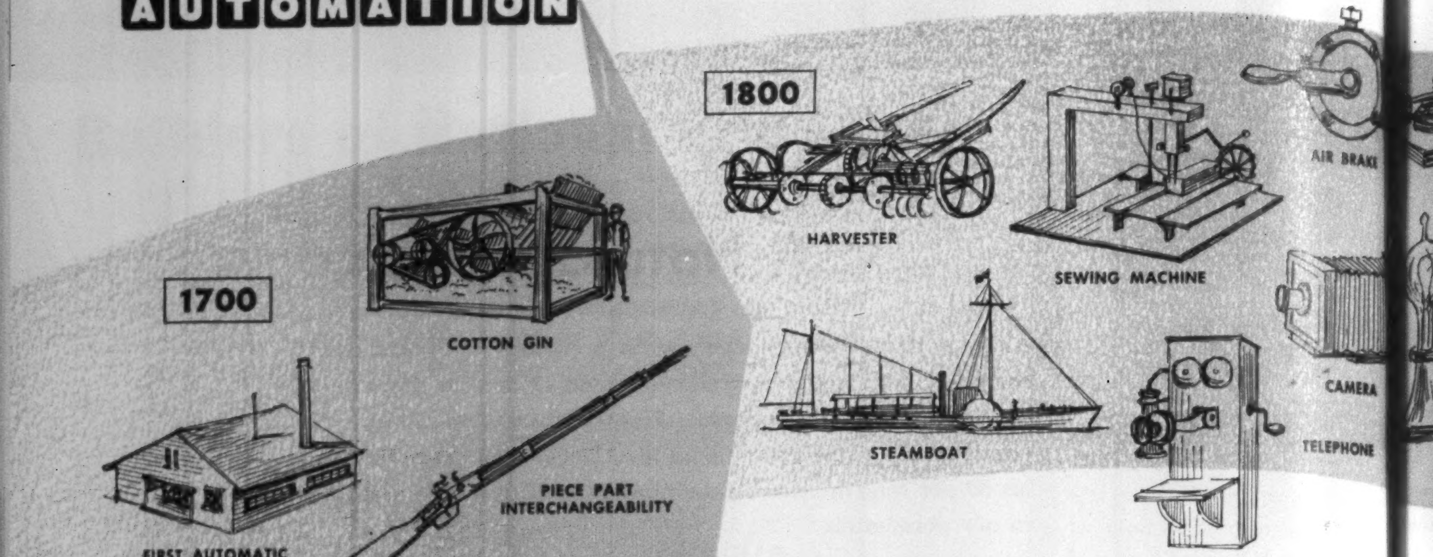
"We are entitled to a cautious hope that automation may afford a partial answer to those who look at the rising educational levels in the country and ask, 'What are people going to do with all that education when they find themselves on the dull and routine jobs of American industry?' *Mechanization* may indeed have created many dull and routine jobs — but *automation* is not an extension but a reversal of this trend: it promises to cut out just that kind of job and to create others of higher skill."

Just how much this increasing education has contributed to the automation trend is difficult to ascertain. But its effects have been present along with those of a rising living standard and market demand. The net result is highly encouraging. Properly applied and implemented, automation offers the only significant answer for some of the complex problems to be surmounted if the tremendous potentials in future personal and material progress are to be realized.

Bolz

EDITOR

AUTOMATION



EVALUATING and PLANNING

Men of responsible positions of management and engineering must not consider automation as just something they think they want and then buy. This introductory article explains the need for each company to make a thorough study to achieve a sound, healthy approach to a goal of practical automation

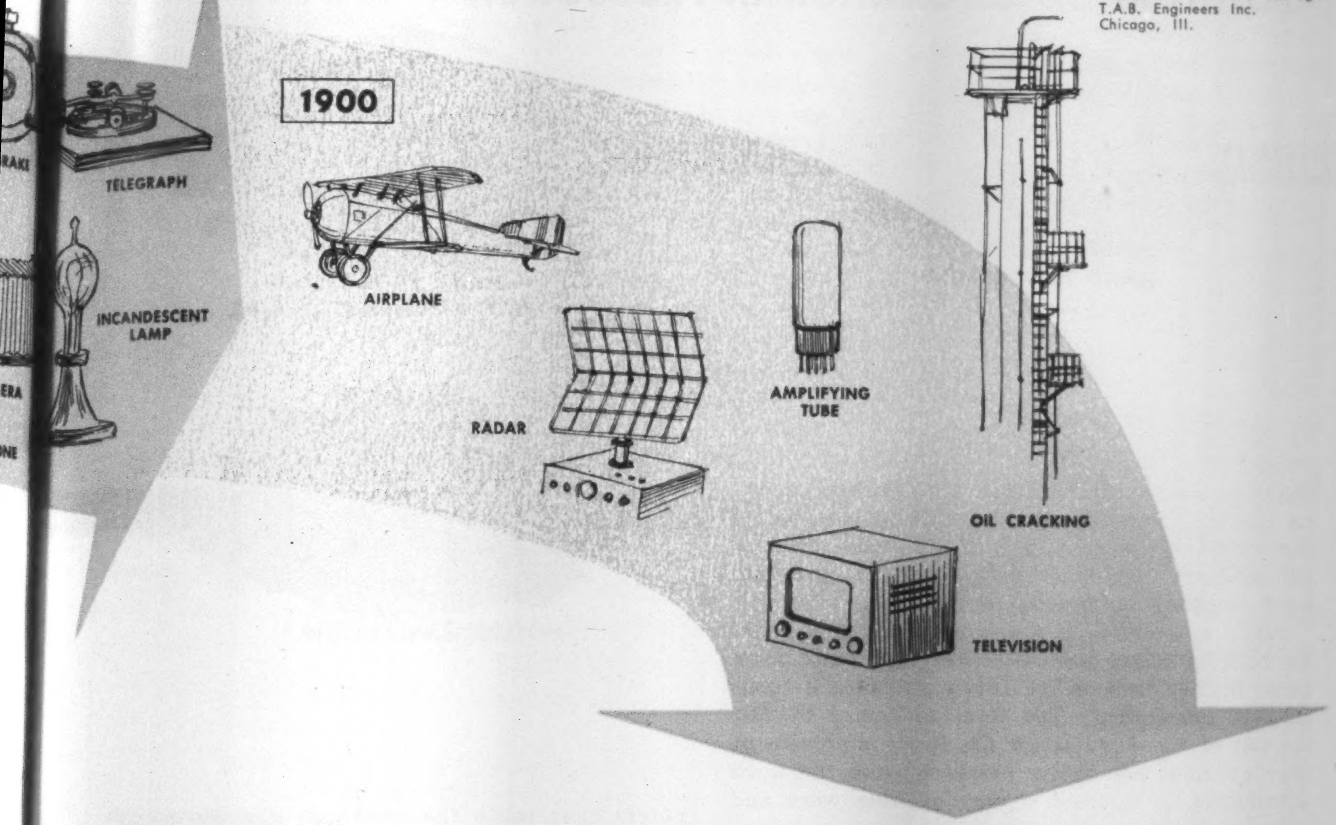
TODAY'S MOST DYNAMIC problem that faces management and engineering executives is "How to plan for automation". This problem has been brought sharply into focus in the past year mainly because of the demand placed upon practically every industry to reduce manufacturing costs, to prepare for the expected increase in future markets, and the greater production necessitated by these increases.

Before we get too far into our discussion of "How to plan" for this exciting industrial period ahead, let us take a look at automation—what it is—where it came from.

There are probably as many definitions of the term automation as there are opinions as to who is the greatest athlete of all times. Usually, these definitions reflect the viewpoint of the author or speaker. As practicing engineers, it is our responsibility to maintain an unbiased point of view, which we endeavor to reflect in our interpretation of the definition and meaning of automation.

In general, automation is a manufacturing concept. However, more specifically, automation to us is the application of machinery to perform and control automatically and continuously all of the manufacturing operations in a given plant—from

By C. E. EVANSON
President and General Manager
T.A.B. Engineers Inc.
Chicago, Ill.



for . . . . . AUTOMATION

the raw materials to the finished product. This includes the automatic transfer of material, automatic control and programming of operations, automatic control of quality and uniformity, and automatic computation and recording of the data.

You might ask: "Isn't that mechanization?" To a large degree it is mechanization; however, automation differs from mechanization in that automation goes one step further. It not only replaces labor to perform the heavy, arduous, and often dangerous functions, but also it replaces the more complex sensory control functions of memory, association, and decision. The overall results, therefore, are (1) balanced production, (2) uniform and controlled quality, and (3) lower costs.

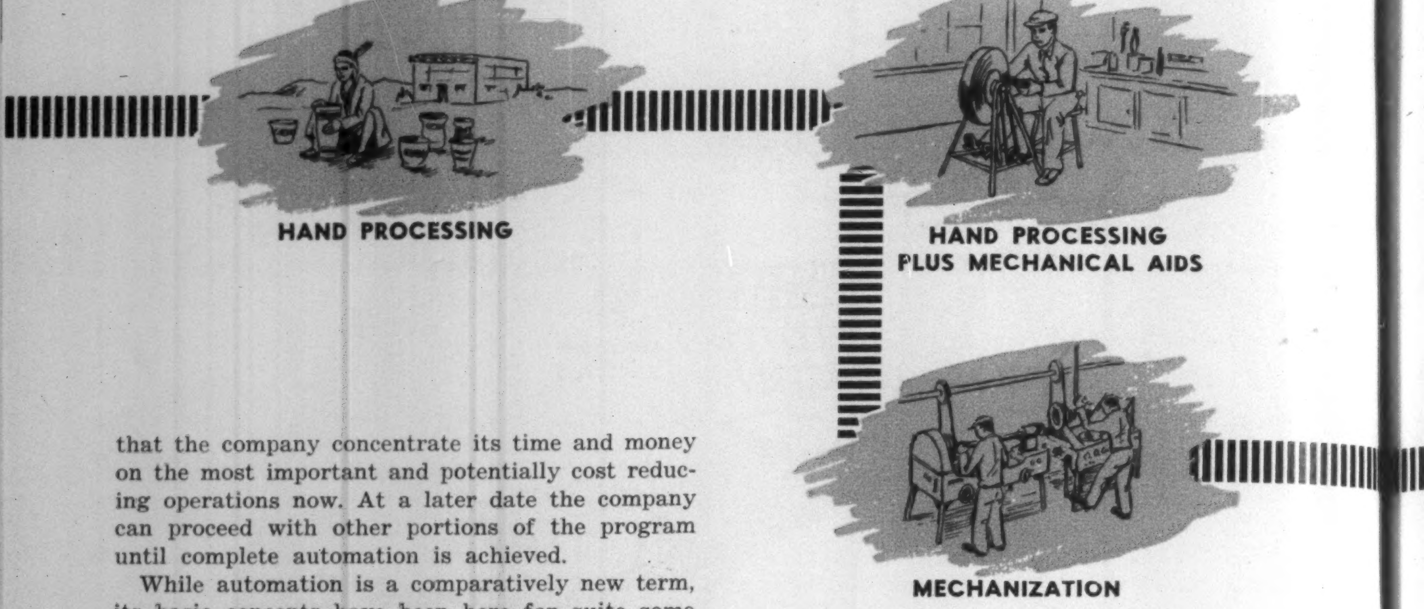
▶ Automation vs Partial Automation

Another term synonymous with, but not as encompassing as automation is "Partial Automation". Since this is the answer to those skeptics who now scoff at any ideas of a completely automatic factory, it is worthy of definition here. Those of us who have been close to the field are well aware of the fact that in some cases complete automation is not, or will not be, in the immediate or even foreseeable future, practical for some companies. To bridge this evolution from mechanization to complete automation will be a period during which partial automation will be the most practical approach to cost and production problems. This simply means that only parts, or phases, of the production will be automated and, usually, it will be those operations where the manufacturing and labor costs are excessive, and where tangible benefits will be realized within a short time. This will enable a company to take advantage of automation without underwriting an exorbitant initial investment for a completely automatic factory.

In defining partial automation we should remember that it is neither synonymous with complete automation nor mechanization. Where a company develops and installs partial automation for one of its operations it does so based upon an overall plan and automation study so that the installation will fit in with total automation at a later date.

For example, we recently developed a program of complete automation for a manufacturer in the food industry. However, our recommendation was

EVOLUTION OF AUTOMATION IN PRODUCTION


HAND PROCESSING
HAND PROCESSING PLUS MECHANICAL AIDS
MECHANIZATION

that the company concentrate its time and money on the most important and potentially cost reducing operations now. At a later date the company can proceed with other portions of the program until complete automation is achieved.

While automation is a comparatively new term, its basic concepts have been here for quite some time. In fact, back in the 1940's we called it "continuous processing". The term as coined by Mr. Harder of the Ford Motor Co. is an improvement over previous descriptive names because the word automation is in itself a very exciting word and more truly descriptive of the meaning and connotations that the term implies.

▶ Origins of Automation

Born almost two hundred years ago, automation is the amalgamation of all the thinking of the industrial geniuses of the past two centuries, and each has contributed his part.

Evans built his "automatic" flour mill in 1783 with conveyors to aid production. Whitney took a great stride with his development of piece-part standardization and the interchangeability of parts in musket manufacture; and Ford added the master touch when he saw the possibilities of the packing house production line technique and adapted it to the manufacture of automobiles. Innumerable others have added their bit to the mass of production know-how, which has made America the leading manufacturing nation of the world and raised its people's standard of living to the highest level in history.

So far, most automation has been achieved because of the gigantic strides taken by the mechanization of factories since the early 1900's. These made it possible to substitute machines for "backbreaking" and time consuming hand work. Now we have the technical advances of recent years, caused by the impetus of World War II, to aid us in overcoming hard labor and slow, difficult jobs—and with considerable improvement in efficiency and accuracy.

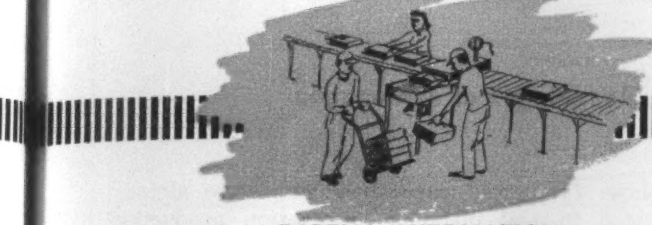
Other recent advances make it possible to program and control plant operations on the basis of data compiled and recorded automatically. Computers have taken the labor out of mathematics; and with automatically controlled mechanized production, it is possible to eliminate all but the minimum of physical effort and on-the-spot decisions in our future manufacturing plants. It is seen that down through the years all of these achievements have been building a pyramid of engineering know-how toward the present climax of what is now termed automation. While the elimination of direct physical labor appears great, the engineering time and effort necessary for successful automation is no less than staggering.

▶ Automation Today

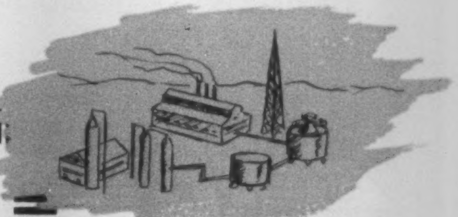
Yes, automation is here today! We have but to look around us and we cannot help seeing the influence of these developments: the electric eye—tape controls—servomechanisms—automatic signaling systems—automatic timing and actuating devices—automatic recording and filing systems—and automatic communication systems. These important component parts have already been combined in many ways to achieve practical and serviceable automation.

The petroleum industry, for example, is largely automatic today; and, the manufacture of parts for automobiles has also felt the beneficial effects of applied automation. The steel industry is another which is being automated; and, our staff members have found during the past few years that automation can also be applied with profitable success to the other industries. For instance, companies in the food processing field, which have lagged in taking advantage of the principles of automation, are now finding that such objections as nonuniformity of raw materials can be overcome.

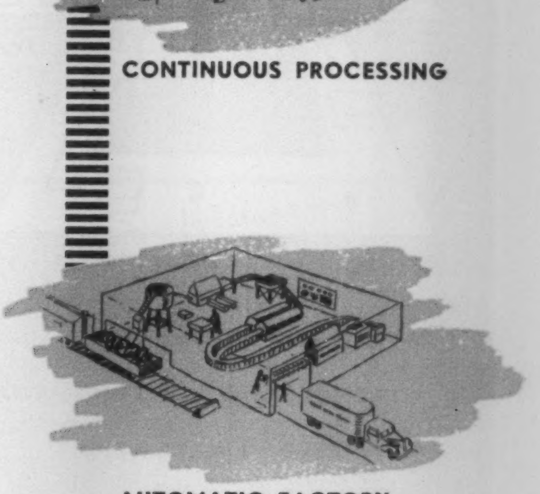
When we realize exactly what has happened in many of these industries, we can appreciate more fully the dynamic patterns of the future. Automation, or partial automation, will be the inevitable answer to problems of growing markets, high manufacturing costs, and keen quality and price competition.



PARTIAL AUTOMATION



CONTINUOUS PROCESSING



AUTOMATIC FACTORY

▸ Available To All

The present day significance of automation is far greater than many chief executives realize. The so-called "blue chip" companies have known for years that including engineering and development work in the allocations of the sales dollar was not only advisable but necessary to permit solidifying their position in the market and also to accomplish growth. On the other hand, there are many medium sized and small companies which have failed to see and appreciate the need for replacing obsolete and costly manufacturing methods with the very latest techniques and principles. We have known companies which had achieved success on the strength of a dynamic owner, favorable business conditions, or a "hot product", but in competitive situations the employment of progressive ideas of modern scientific plant management is imperative.

As a part of our responsibility, we naturally recommend to our clients that they keep pace with the inevitable trends. It is significant to observe that the wise and courageous business and industrial leaders are planning to be ready for the increased market in the 1960's and beyond. It is they who realize that they cannot rest upon their laurels, nor can they sit and wait to see what happens. Instead they must act, and act in a very positive manner now!

This may seem like bold talk. This may seem to some like impractical talk. But the fact remains that as we look at the industrial picture from our vantage point of objectiveness, there is no question about the industrial future of America. In spite of negative thinking, regardless of wars and depressions, American industry has always moved forward; there is nothing in the economic or social pattern of today to indicate that this progress will be stopped. In fact, automation will be the answer to many problems with which industry will be confronted, not to mention numerous benefits and advantages that will be accepted as commonplace things in the next two or three decades.

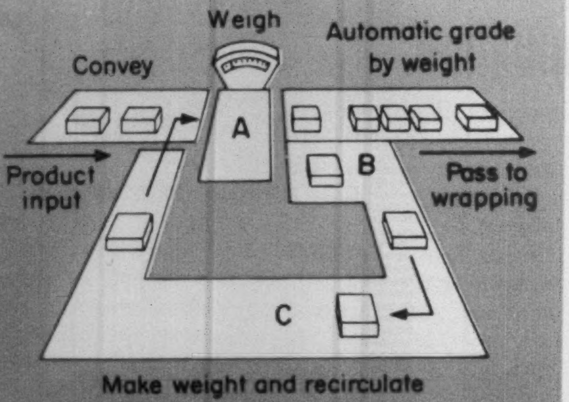
Actually, it is the últimate need for greater production, lower manufacturing costs, and controlled quality which is stimulating automation and partial automation. The manufacturer who does not look into the future and who does not plan for it may well become, or be permitting his company to become, just another name in the history book of those companies which did not stay in the challenging race toward automatic factories.

Today's executive will do himself, his stockholders, his employees, and his customers a justifiable favor if he will but take time to look objectively at his company as if he were a consultant without any preconceived notions or prejudices. In that way he may see not only the future trend of American industry but also the future trend of his own company in relation to the overall picture. If he will do that, the chief executive will realize that this trend is something that cannot be stopped, but automation is something for

PARTIAL AUTOMATION

PRACTICAL FOR ANY SIZE COMPANY TODAY

AUTOMATIC RE-CIRCULATION OF PRODUCT

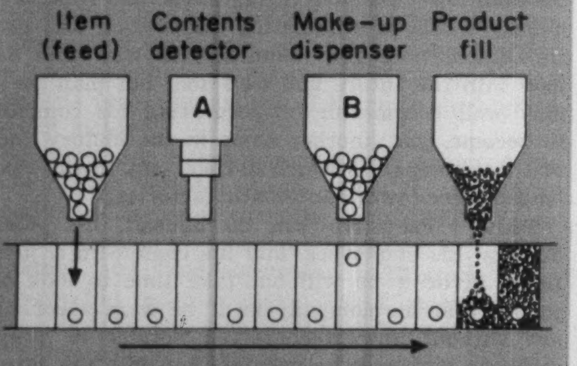


A WEIGHS AND SIGNALS . . .

B TO REJECT OFF-WEIGHTS AND SIGNALS . . .

C TO ADD PROPER MAKE WEIGHT.

AUTOMATIC DETECTION AND MAKE-UP OF PACKAGE CONTENTS . . . COUPONS, PRIZES, AND THE LIKE



A DETECTS LACK OF ITEM AND SIGNALS . . .

B TO AUTOMATICALLY MAKE-UP

which he should plan now to take advantage of in the years ahead.

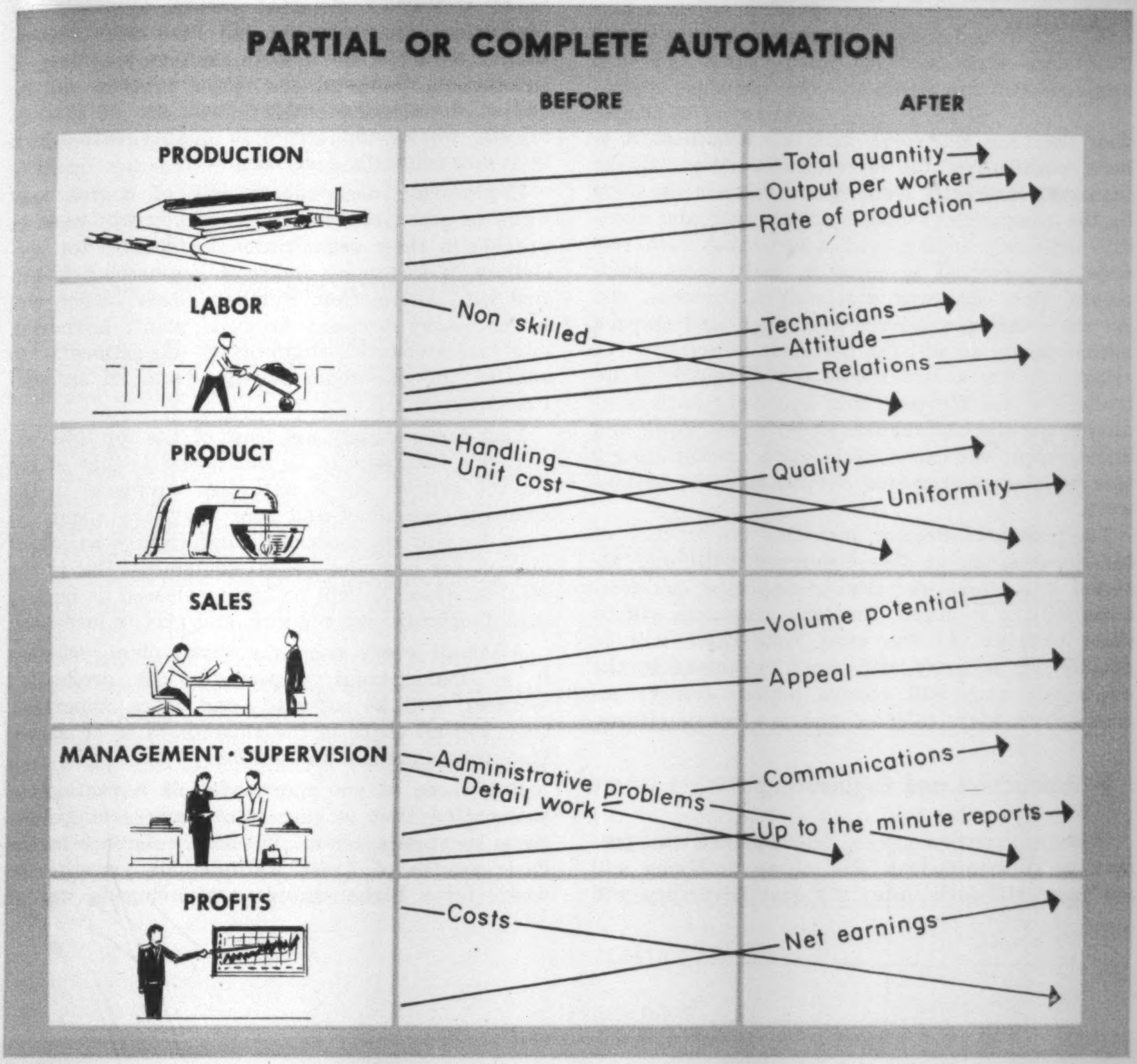
Not too long ago one of our clients in the electrical field had a cost and competitive price problem. After studying his problem thoroughly, we told him, "Automating your production completely is the only thing which will permit you to continue marketing this product on a profitable basis." The item required high production and low cost and an analysis of the market revealed that it would be in demand for a number of years. Therefore, temporary cost cutting measures for the sake of expediency could not be justified, but rather in this case it was a question of going into complete automation.

▶ Advantages of Automation

Those farsighted executives who have already invested in and installed automation production systems in their plants know the many potential advantages to be gained from automation. Now, let us consider some of the most obvious and important advantages which have already accrued to those companies which have installed partial or complete automation.

Most important today is the fact that automation definitely helps to reduce manufacturing costs in several ways. For example, with automation the average and total output per worker is increased sharply. In other words, the worker's efforts are multiplied so that volume can be increased or maintained at a steady level and at a lower unit cost. Another way that costs are reduced is through the curtailing of spoilage and rejects. In automation, since the element of human error is minimized or eliminated, the resulting product is improved and the quality is automatically controlled. Sometimes the savings in spoilage alone justify automation.

Another advantage of automation is increased production. This will be increasingly significant during the next ten or twenty years. It should be remembered that while in some cases it appears to the casual observer that automation replaces labor, that is not true and is *not even the ultimate objective.* The purpose of so-called labor saving machines is actually to increase the productivity of labor both individually and collectively. In very simple terms, an employee has but two hands, two eyes, two ears—limited capabilities of his limbs and sensory organs. Therefore, he can do just so much work with those two hands. He can see just so much with those two eyes. He can think only so fast, etc. But give him a machine that will help to do the work—that will help to inspect the product—and that will help him to test the quality—that will help him to make decisions—and we find that production is automatically stepped up in every phase of the operation. When magnified to present day thinking, it can easily be seen that the total productive effort of the entire



PARTIAL OR COMPLETE AUTOMATION

BEFORE
AFTER
PRODUCTION
Total quantity
Output per worker
Rate of production
LABOR
Non skilled
Technicians
Attitude
Relations
PRODUCT
Handling
Unit cost
Quality
Uniformity
SALES
Volume potential
Appeal
MANAGEMENT · SUPERVISION
Administrative problems
Detail work
Communications
Up to the minute reports
PROFITS
Costs
Net earnings

country is due to this very principle which permits each worker to produce more and more goods by taking advantage of machinery and equipment to multiply his own individual efforts. The same thing is prompting most companies to plan ahead for greater production and greater markets, and this can be accomplished only through automation.

▶ What About Sales?

With improved quality, increased production, and lower costs it is obvious what automation can do for the sales department. Most sales executives will admit either publicly or privately that a product is "half-sold on the production line". By that they mean, of course, that the designing, styling, quality, and price of the product are all important to the salesman. It means the difference between a successful sales effort and an unsuccessful sales effort. Even the most ingenious and progressive sales campaigns cannot entirely make up for deficiencies in product quality or price. Given top quality at the lowest possible price, the sales department can then achieve new records in the distribution of its product.

Take almost any competitive item, improve and maintain its quality, reduce its cost, and the resulting jingling of the cash register will be heard often and long. The total results of increased productivity, better quality, less spoilage, greater sales, and lower manufacturing costs, can really mean more attractive profits to the company and stockholders.

Another department which will benefit from automation will be that of the comptroller. It is his division which is responsible for all of the records and financial controls. Comptrollers everywhere know the headaches resulting from delays in supplying important figures to management.

Yet, the time will come, and in some cases it is here, when all of the factual information will be transmitted directly from the machine in the shop to the comptroller's office to facilitate and expedite invoicing, billing, and maintaining such records as perpetual inventories, daily sales, shipments, flow of parts, materials in process, etc. As an order is received, processed, and shipped automatically so will the pertinent information be relayed to the central nerve center in the comptroller's office for recording and computations at almost unbelievable speed. Department heads and management will have information at their finger tips which now requires several days of tedious work.

The personnel director, including the function of his department, is also concerned with and affected by automation. Higher employee qualifications will be required. Training programs will be more complex. At the same time there will be greater job security and, most important to the employees, they will receive higher average incomes from more talented and productive efforts.

▶ Production and Engineering

With automation comes problems for the production superintendent. But those problems will not be particularly new; it's just that they will be of a slightly different nature. Certainly the production superintendent will have more responsibility with the much more complex machines of automation. However, the major problem will be one of maintenance rather than one of product rejects, waste, and errors in quality with which he is now primarily concerned.

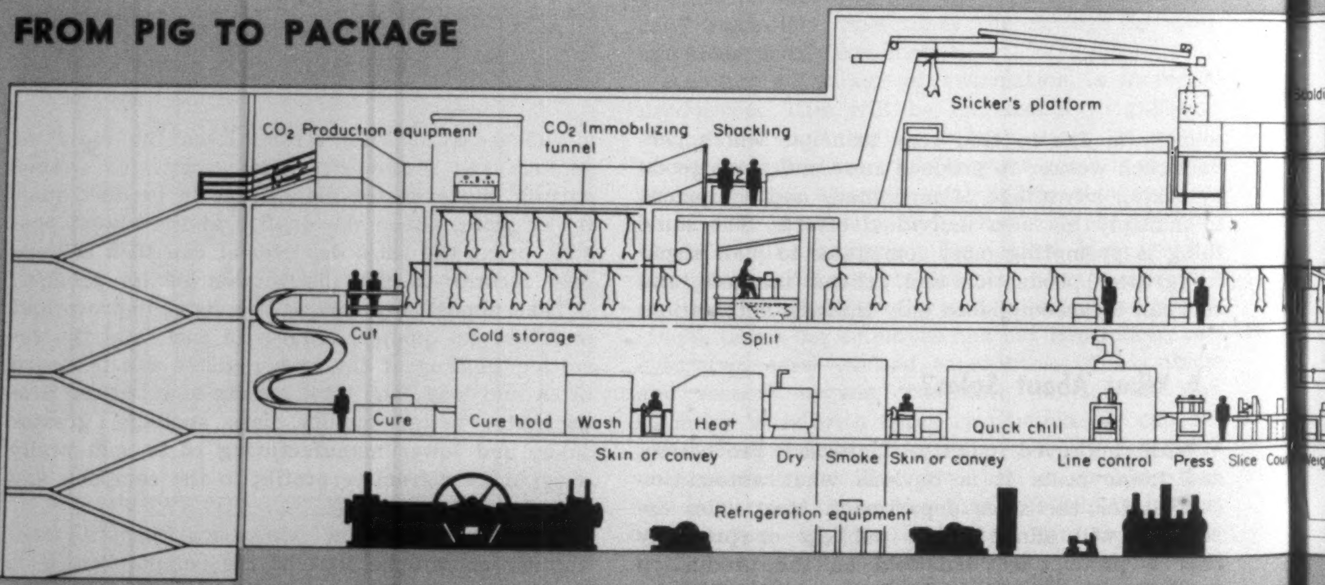
Engineering departments will, of course, continue to grow, and in so doing they will want to provide in their organizational structure for specialists in the many fields of engineering identified with automation. Further, closer liaison will be necessary between product, plant, industrial, and maintenance engineering departments to achieve the maximum benefits from an automation program.

Last but certainly not least of the top level executive's functions to be mentioned is that of the finance officer. He is naturally interested in the company resources and how they are spent. At first he will be concerned, and rightly so, about outlays for new and special equipment. But in the final analysis, he will be highly pleased as he sees manufacturing cost reduced, and profits increased.

All-in-all every one in a given plant, whether it be management, supervisors, or production workers, will be affected—and more important, they will all share in the advantages to be gained from the marvels of automation.

But there is one more over-all advantage to automation that is even more far-reaching than those mentioned above. We have reference to the basic motive of America's fabulous growth—the desire for a higher standard of living—a way of

FROM PIG TO PACKAGE



AUTOMATIC PRODUCTION OF BACON

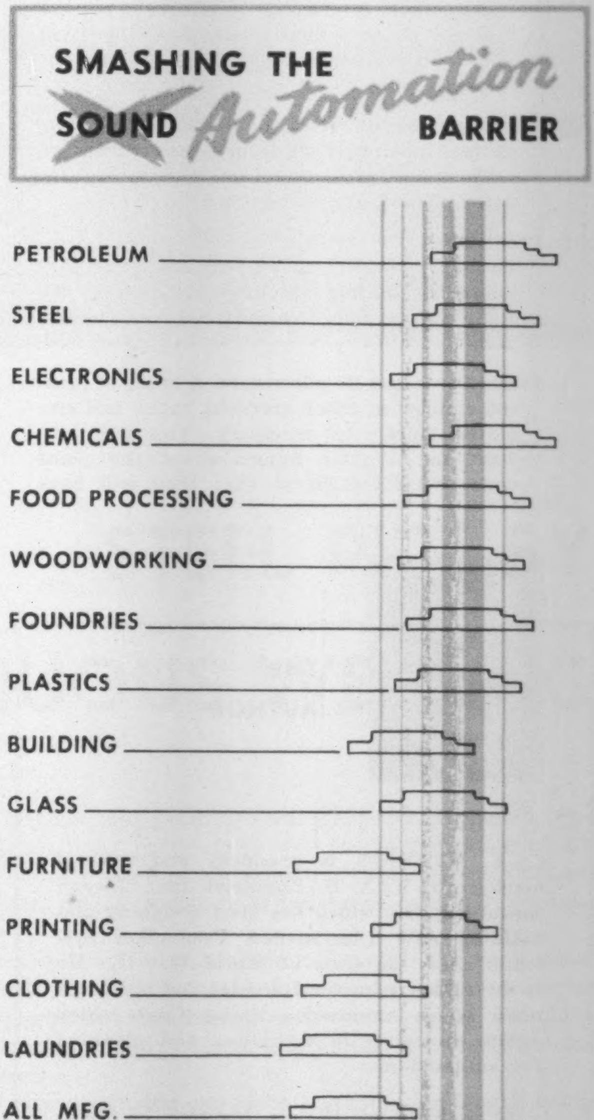
working and relaxing with the utmost convenience. With every technological advancement, in spite of the unfounded cries, "machinery puts people out of work", the United States has achieved its exciting and comfortable standard of living *because* of technological advances and *not* in spite of them. Automation now opens the door to a brilliant future of new products and comforts for more and more people everywhere.

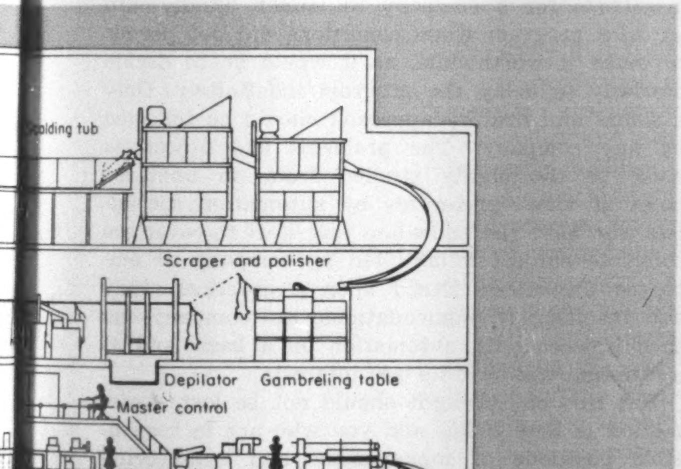
▶ Planning For Practical Automation

True, progress requires adjustments, but as we see it, everything points to a general improvement and raising of living and working standards through the automation development of the next two decades. But, some will still say, "Automation is not practical." or "Automation is still in the dream stage." These statements are, of course, not based upon a true understanding of the subject.

To those of us who have actually applied automation successfully, we know that automation not only is possible, but that it is definitely necessary. In fact, there are some industries which should take advantage of it immediately. It is within the grasp of many manufacturers right now and there are many companies which will find it difficult to justify any delays in adopting a plan immediately for partial automation or complete automation. As a matter of fact, today most of our clients are either considering or developing automation in their plants. This is being done on what we refer to as a practical, step-by-step basis consistent with the many requirements of automation and the company itself. It is understandable that automation must be approached from a "dollars and sense" point of view, since each company's problems and objectives are different and unique in themselves.

When our clients come to us and ask what they should do about automation, or ask if they need it or tell us that they want automation, we im-





mediately tell them that automation is not just something that you think you want and then buy. Instead, automation requires a special technique of analysis—a thorough study before any APS (Automation Production System) can be designed, developed or installed. Moreover, we must remember that every function of the business is affected: —accounting, engineering, finance, production, distribution, and personnel. In addition, the following must also be studied carefully and evaluated when planning ahead for automation:

1. **Product.** Your product or products must be analyzed to determine if and how they will lend themselves to automation or continuous processing.
2. **Manufacturing Plant.** You must analyze your factory building considering such things as straight-line production, the nature of construction, and age of the property.
3. **Production.** The type of production and production equipment in current use have considerable bearing on whether or not the plant can or should be adapted for automation.
4. **Labor Force and Requirements.** A study of present employees, labor markets, rates, and employee morale is necessary. You will also want to enlighten unions about the plans under consideration so that they will have a clear understanding and will be able to cooperate with the program.
5. **Production and Labor Cost.** An analysis of these will be relatively simple. Most companies today are very much aware of their production and labor costs. The cost of materials handling, supervision, direct labor and inspection should be included in this study.
6. **Capital.** Capital is certainly of importance in any short or long-range development program. The amount of capital directly or indirectly available and the amount of capital required for the program must be determined as early as possible. In fact, a thorough analysis of the company's financial condition and outlook will have a decided bearing upon detailed plans for automation.
7. **The Future of the Company.** Any decisions relating to automation will necessarily take into account the future aspirations and desires of management and owners. Specifically, the recent sales trend of the company, plus the present outlook, the current earnings and potential profits are all factors to be considered.

A complete analysis of the above seven subjects will help management determine a practical detailed approach to automation. It will help to determine whether or not the company is ready for automation. It will help to determine if the program should proceed immediately and it will also help to determine the best procedure to follow.

The Time Is Now

However, the important thing is that a hasty decision should be avoided. It would be just as disastrous for a company to launch blindly into an APS program when conditions did not permit or make it worthwhile, as it would be to decide unwisely to delay the program indefinitely. Only a sound and healthy approach should be followed by any company. The problems and objectives must be thoroughly studied from an unbiased point of view—preferably by automation specialists who have the know-how and staff to cover the complete subject uninhibited by company or employee prejudices. Based upon a practical study and resulting recommendations, the company can then proceed with automation on a basis and at a rate that will be in its best interests.

But this one thought should not be lost. Automation is here today and you who are in responsible positions of management and engineering do not want to permit your company to lag behind in this progressive and worthwhile trend. A manufacturer whose products can be made by either continuous processing or straight-line production is losing money every day he thinks about automation but takes no action. And, if he is not thinking about it, he should be.

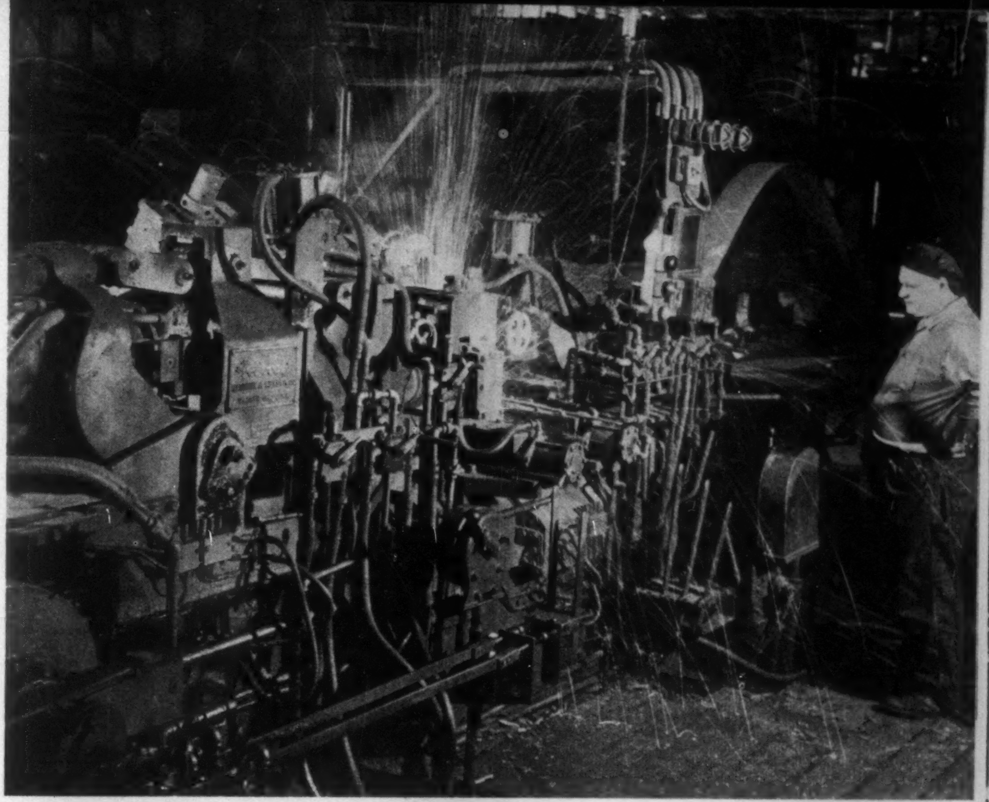
The best way to be ready for the future is to plan for it today.

THE AUTHOR

C. E. EVANSON is president and general manager of T. A. B. Engineers Inc. Chicago consulting firm which has been designing and building APS (Automation Production Systems) since the close of World War II. He is the author of several articles and the originator of an Automation Rating Chart which assists executives in evaluating and planning for automation.

A graduate of Illinois Institute of Technology (B. S. M. E.) Evanson is a member of Tau Beta Pi; former plant process engineer, Dole Valve Co.; production engineer Prismacolor Inc.; assistant chief tool engineer, Link-Belt Ordnance; and assistant sales manager, Barnes & Reinecke Inc.

In addition, Evanson is a member of ASME, SAME, ASTE, Illinois Chamber of Commerce, and an executive member of the Civic Policy Group of Mayor Martin Kennelly's "Committee for a Cleaner Chicago".



1

Beginning of automation in making continuously welded steel pipe is at flash-welding machine, where coils of flat beveled steel, known as skelp, are welded end to end to form a continuous strip. Welding is automatic and averages half a minute for each weld and removal of excess metal

AUTOMATION TODAY

STEEL PIPE BY CONTINUOUS WELDING

STEEL ROLLING MILLS that produce basic shapes represent a type of production that lends itself particularly well to the utilization of automation techniques. They are part of an industry that has long reaped the quality and cost benefits of plant-wide installations of continuous manufacturing facilities.

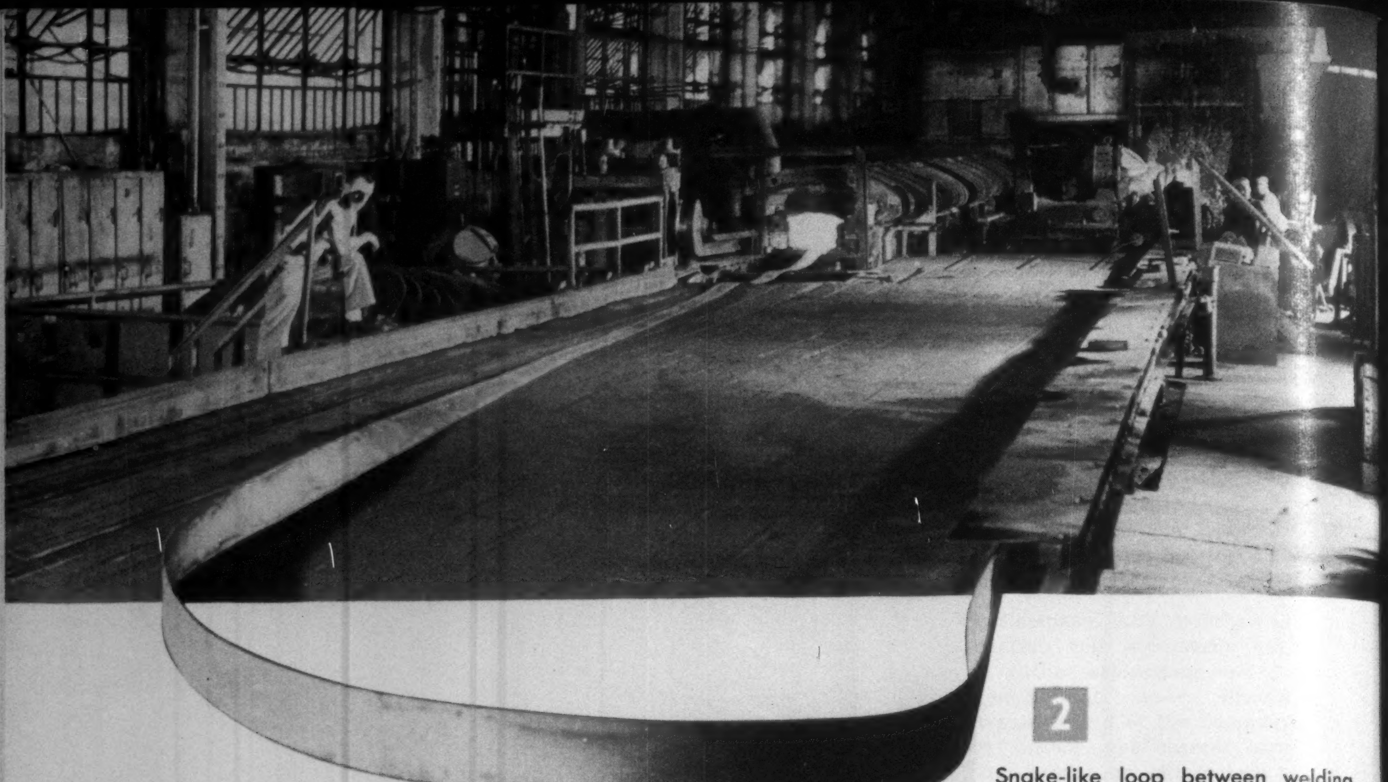
Automation got an early start in many pipe mills when the continuous weld process replaced earlier methods that involved more arduous human labor. Among the first plants to adopt this process was the Etna, Pa. plant of the Spang-Chalfant Division of the National Supply Co., where the accompanying pictures were made.

By earlier methods, pipe was made one piece at a time, its length being limited by the length of the furnace. In the continuous weld process, originated by the Fretz-Moon Tube Co. in 1921, pipe is made in a continuous piece, and is sawed into suitable lengths to facilitate handling and shipment.

Coils of strip steel, known as skelp, are flash-welded end to end to form a continuous strip for the process. From the moment the skelp enters the furnace until it emerges as red hot pipe, all operations are automatic and follow one another in rapid sequence.

This plant now has a ten stand continuous weld mill, used in making ½-inch to 2-inch pipe, and an eight stand mill, used in making sizes to 4 inches. Each has its own gas-heated furnace, controls, and other equipment.

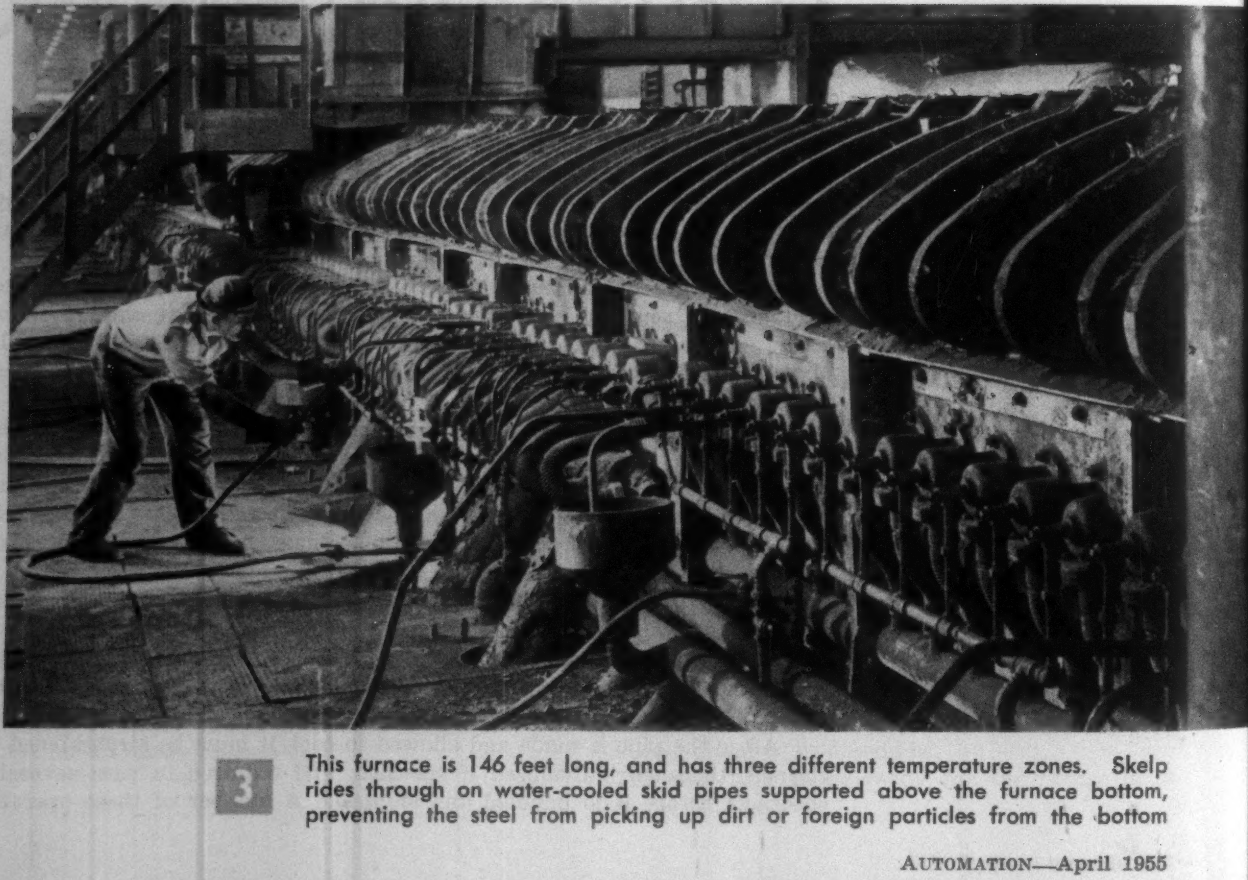
After the pipe is made and allowed to cool, it must be straightened and cleaned, threaded, galvanized if specified, and required to pass several inspections before it is bundled and shipped. A number of these operations



2

Snake-like loop between welding machine and furnace allows the necessary slack so that skelp can move at a steady rate into the furnace, despite the time required to weld the separate coils into a continuous strip

are also automatic, and conveyor rolls carry the pipe from one step of the process to another. The Etna plant was established in 1828, when the pipe most commonly used was made of wood. Now it is one of the principal sources of steel pipe and steel electrical conduit with a capacity of 270,000 tons a year.

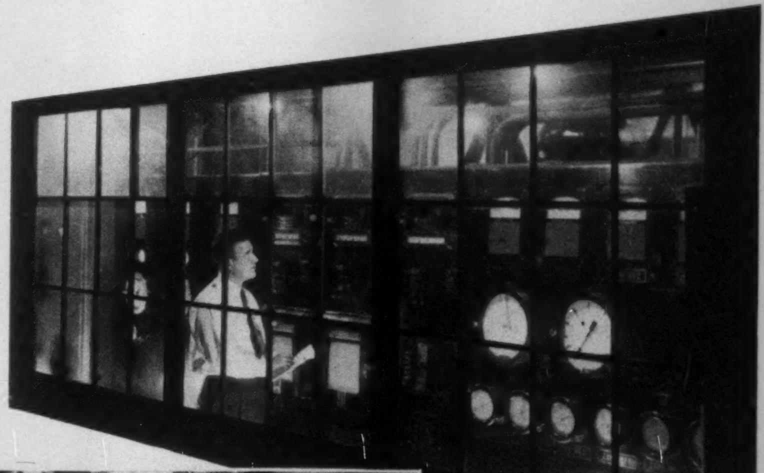


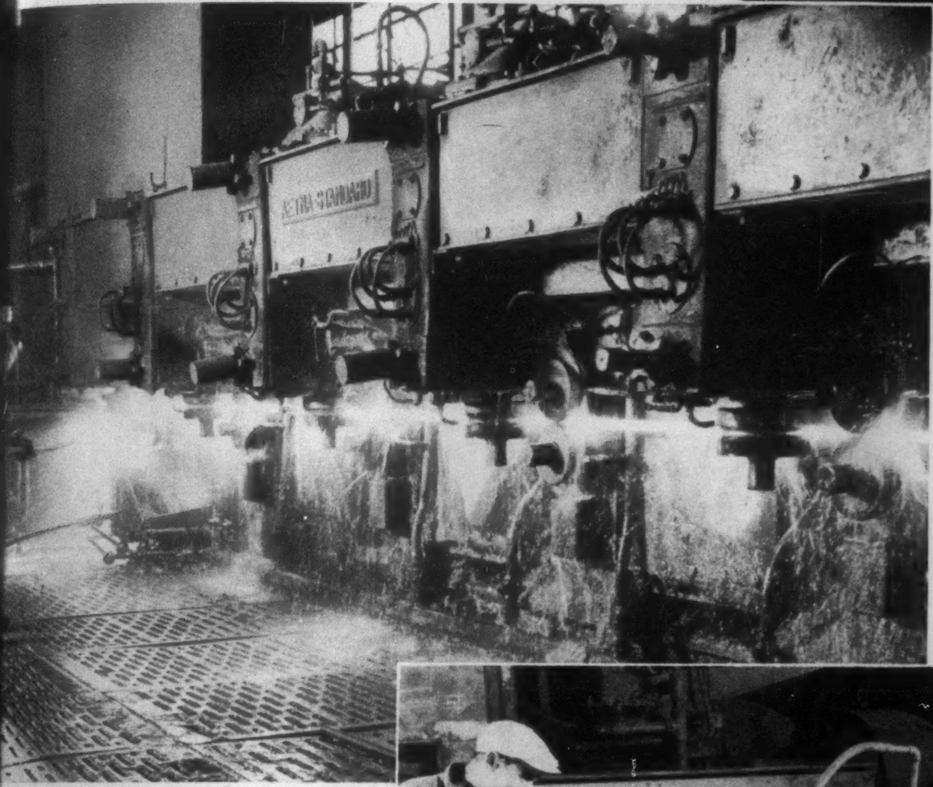
3

This furnace is 146 feet long, and has three different temperature zones. Skelp rides through on water-cooled skid pipes supported above the furnace bottom, preventing the steel from picking up dirt or foreign particles from the bottom

4

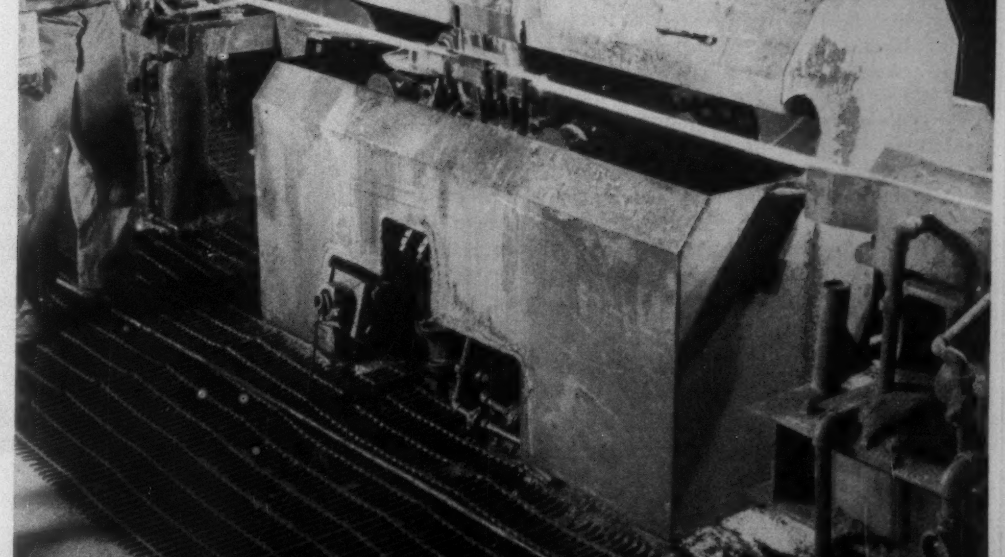
Bank of instruments keeps furnace temperatures within close limits and controls equipment for maintaining high combustion efficiency. Furnace has 274 burners along each side, spaced 9 inches apart, and arranged to heat edges of the skelp to the highest temperature





5

Red-hot skelp is formed into tubular shape, squeezed together at the edges, and progressively reduced in diameter and lengthened by the rolls of this 10-stand mill. Rolls are in alternating vertical and horizontal pairs, or stands



6

Leaving the mill at speeds exceeding 500 feet per minute, hot pipe is cut into the required lengths without slowing down. Rotary saw rides along with the pipe, cuts it, then whips back to cut the next piece. After cooling, pipe is ready for other processing

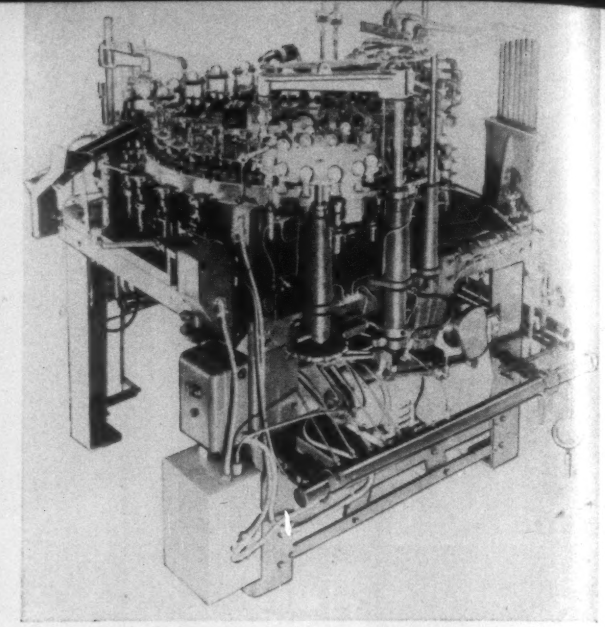


Fig. 1—Bulb fusing and exhausting machine used in the manufacture of miniature or standard photoflash lamps, gas-filled lamps and vacuum tubes. The unit synchronizes two steps in fabrication that were previously done separately and includes 24 sealing and 24 exhaust heads

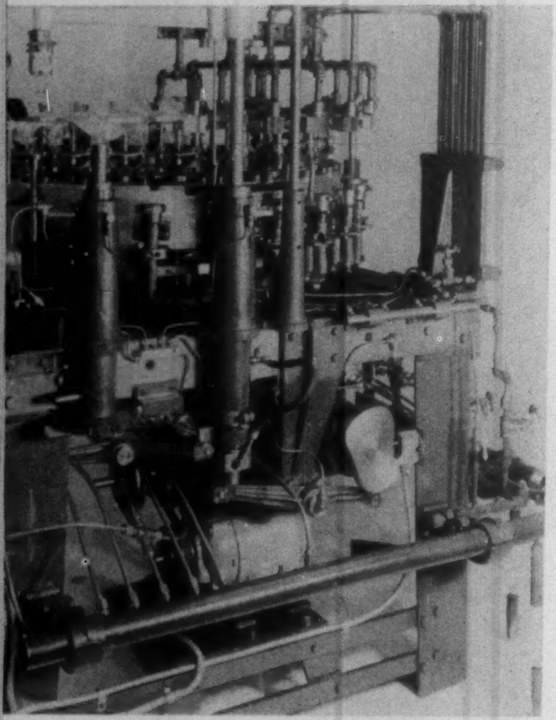


Fig. 2—Auxiliary bulb supply turret showing the cone shaped lifter and transferring arm. These two components transfer bulbs from the small turret to fusing heads on the large turret. If a stem is not loaded in a fusing head, transfer movements are arrested by a solenoid energized from a feeler arm

MACHINE

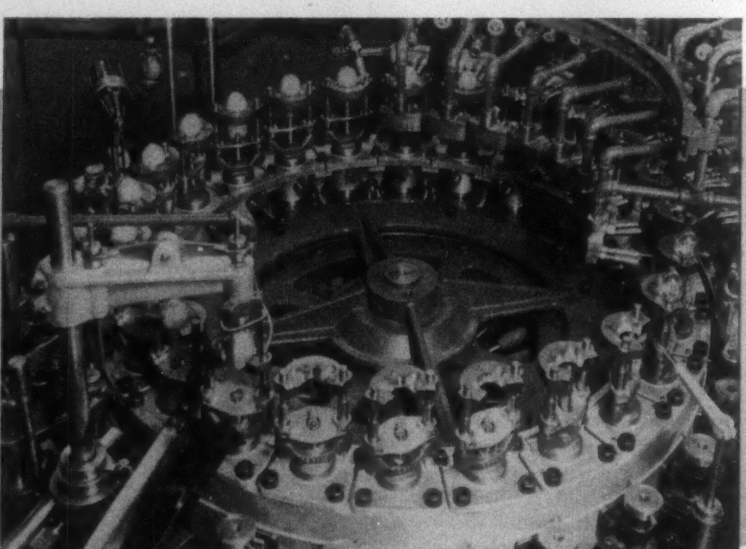


Fig. 3—Transfer arm which removes fused bulb and stem assemblies from the heads and inserts them in the exhaust heads. Flame jets on the far side of the turret have performed the fusing operation. Dog and pawl device in the foreground tightens a rubber seal in the exhaust head around the stem of the bulb assembly so that a vacuum may be drawn in the tube. Should a faulty lamp be inserted into the exhaust head, a detector system causes closing of the pinch cock on that particular head

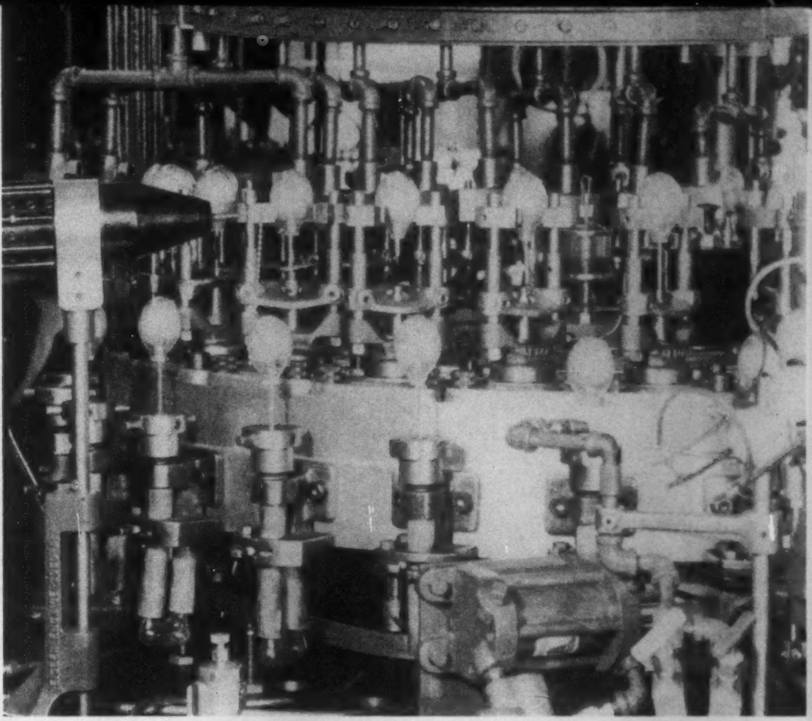


Fig. 4—Flame jet to seal the vacuum is shown adjacent to the discharge chute. Upper row of bulbs in the fusing heads will be transferred to empty exhaust heads just beyond the discharge chute. Prior to sealing, bulbs can be filled with an active or inert gas, if required

AUTOMATES GLASS BULB MANUFACTURING

GLASS FUSING, evacuating and sealing processes have become progressively more automatic with growth of the light bulb industry. These developments have been applied in the electronics field to manufacture of vacuum tubes and also to photoflash bulbs, introducing automation to assembly of these products.

Fusing and exhausting of bulbs usually have been performed on two separate machines. The Eisler Engineering Co. has developed a synchronized machine, *Fig.* 1, in which all operations are powered from the same main shaft, saving space, reducing labor requirements and producing 1600 to 1800 sealed and evacuated bulbs per hour.

Fusing heads are located on the top face of an indexing turret; exhaust heads are around the periphery. Glass stems are loaded manually into the fusing heads and bulbs are automatically transferred over the stems from an auxiliary supply turret, *Fig.* 2. These two elements are fused by a series of flame jets as they move counterclockwise on the turret.

After traveling about 270 degrees, fused assemblies are transferred to the lower exhaust heads by a cam controlled transfer arm, *Fig.* 3. These exhaust positions are equipped with rubber seals which are automatically tightened around the stems after loading and released before unloading. The final operation, performed while bulbs are still in the exhaust heads, is flame sealing after the vacuum has been created in the bulbs, *Fig.* 4. An extractor lifts completed bulbs from exhaust heads and deposits them in a slide for transfer to the socket mounting operation.

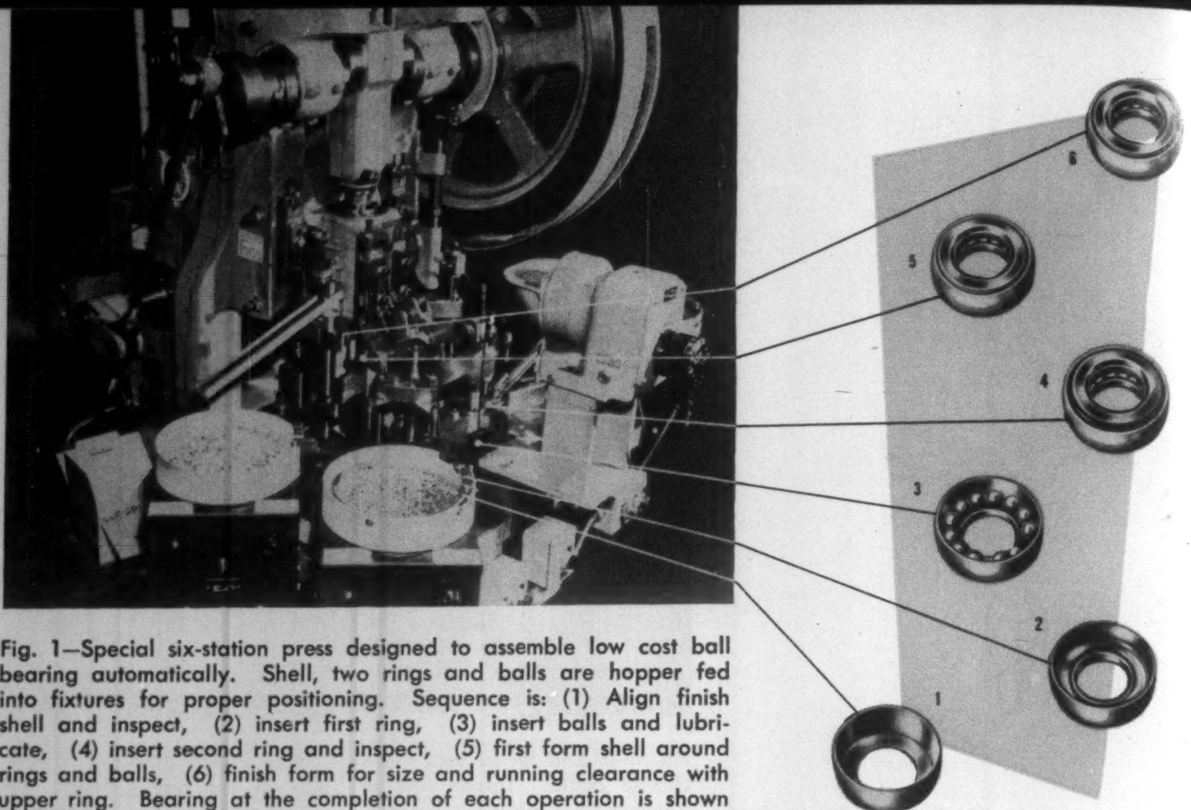


Fig. 1—Special six-station press designed to assemble low cost ball bearing automatically. Shell, two rings and balls are hopper fed into fixtures for proper positioning. Sequence is: (1) Align finish shell and inspect, (2) insert first ring, (3) insert balls and lubricate, (4) insert second ring and inspect, (5) first form shell around rings and balls, (6) finish form for size and running clearance with upper ring. Bearing at the completion of each operation is shown in detail illustrations

ASSEMBLING SMALL BEARINGS AUTOMATICALLY

AUTOMATIC ASSEMBLING of components into a finished item is one of the more difficult areas of applied automation. In some cases, though, this type of assembly is a necessity if the part is to be produced economically.

An interesting case in point is the production by New Departure Div., General Motors Corp., of a small, low cost, ball thrust bearing used for door hinges of various kinds and similar other low-speed applications. The bearing has a 0.280-inch bore outside diameter of 17/32-inch and a width of 0.228-inch. Its static load rating is 500 pounds with rating of 100 pounds at 500 rpm.

Manual assembly and handling cost for this size bearing would be prohibitively expensive considering intended application and quantities desired. Keying the method of production into allowed tolerances led to the development of a special multiple-station press for automatic assembly. With this machine, present cycling produces 52 completed bearings per minute. A shell, two rings and proper number of balls are fed from four vibrating hoppers into magazines which place the parts in correct position at positioning stations. Actually, the machine indexes through four positioning stations, two inspection stations and two forming stations.

Machine assembly is possible because of the unique inspection features incorporated in the design of the press. For instance, the vibratory automatic feeder is engineered to feed shells with open side up. Safety station follows this first station which will stop the machine by means of limit switches if there is no shell in the dial or if the shell is out of shape. Rings are properly oriented in same manner as the shell. Second safety station precedes first forming station. Cycle of the machine is automatically stopped by means of limit switches if high or low assemblies are detected at this station. Unsatisfactory parts are manually rejected. After the two forming operations and as a final step, completed bearings are automatically counted into suitable lots and deposited in shipping containers.

By **C. W. WORLEY**
Application Engineer
Brown Instruments Div.
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

BASIC PROCESS CONTROL

AUTOMATIC CONTROL FUNDAMENTALS

Fundamental principles of automatic control stress a basic approach through mathematical treatment. Electrical, hydraulic, mechanical, pneumatic, optical, thermal and combined systems may be designed by energy transfer analysis methods to control any variable. But mathematical treatment cannot be applied to people; a gap exists between those who make control equipment and those who use it. This series of articles will help each understand the problems of the other so that increased applications of automatic control can be realized

IMPORTANCE of automatic control has grown tremendously in almost every industrial activity during the past decade. New principles of measurement have introduced a host of new systems for detection and control of process variables which previously were measurable only on a laboratory scale.

In automatic control, a system composed of certain selected components is so arranged to cause a processed material to take on a specific quality or characteristic. The process itself is considered as a component of the system. For economic reasons, quantity and quality of the output, and sometimes quantity of the main power component, fuel to a furnace for instance, serve to determine the type and degree of control needed.

In the past it has often been adequate to know merely that automatic control instruments eventually cause a process to work at some new level. Satisfactory control systems were worked out through intuition, past experience, or trial and error, knowing that a process will move from one steady state value to another with a change in operating conditions. Today, however, such a procedure is no longer suitable.

Processes now exist where the time required by the variable in moving from one value to another is not the only critical characteristic—the

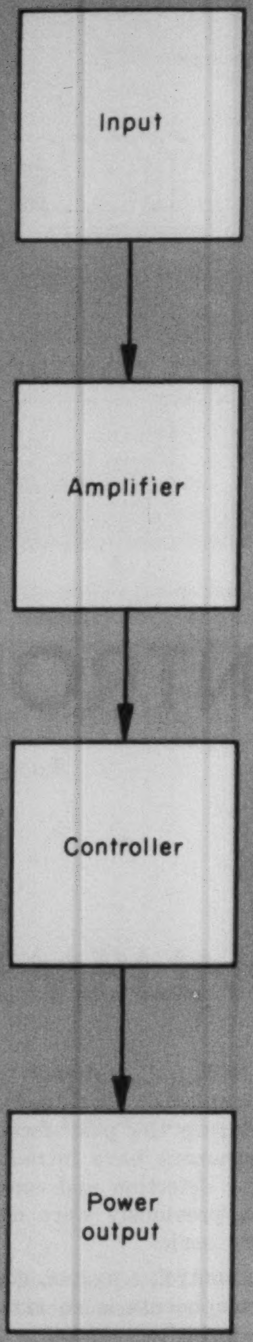


Fig. 1—Basic components of an open-loop control system. There is a theoretical linear relationship between the input command and power output, modified by effects of outside disturbances on components of the system

path taken in making the transition is also critical. These characteristics, time and path, are known as the dynamic characteristics of a system. For example, in many startups the variable must arrive at the set point not only as quickly as possible, but also with a minimum of overshoot. Similar processes impose other restrictions upon both the path and time of the change.

Position of the controlled variable as a functio of time is dictated by transfer of energy througl out the system which has two conditions of ope ation—steady-state when the system is at res and transient operation from one steady-stat condition to another. The control system the possesses steady state characteristics as well a dynamic characteristics. Therefore, design of a automatic control system evolves into realizin these characteristics by means of suitable compo nents fitted to the control loop.

▶ Development of Controls

Beginning with the steam engine and other material improvements brought about in the Industrial Revolution, man has had available greater quantities of power for his use. To utilize this power effectively, he has been required to learn how to control and regulate it.

One of the earliest forms of automatic regulation was the centrifugal steam engine governor invented by James Watt in 1784, and even this can be shown to have predecessors in the regulation of windmills. First appearance of the term "servo" now used extensively in the automatic control field, was made by Joseph Farcot in his book *Le Servo-Moteur Ou Moteur Asservi,* published in 1873. He defined it as putting "any motor or engine under the absolute control of an operator by the movement of his hand directly or indirectly on the control member of the motor, so that the two go, stop, move back and forward together, the motor following step by step the finger of the operator, imitating as a slave every movement." This would appear to be the origin of the term "slave" as applied to the repeating motor, and is considerably different from the present-day closed-loop positional servo. Farcot also stated in the book that his servomotors had been applied to gun turrets as well as rudders of four French gunboats.

First application to ship steering gears is attributed to F. E. Sickels of New York who obtained patents in 1853 and 1860, but may have been working on the invention as early as 1849. Hydraulic apparatus for steering gears was invented in 1870 by Andrew Betts Brown working for the British Royal Navy

Earliest evidence of automatic control applied to industry was in 1784—before the Industrial Revolution began—by Oliver Evans who built an entirely automatic factory near Philadelphia, a continuous process flour mill. And in Paris, in 1801, Joseph Maire Jacquard exhibited an automatic loom controlled by punched cards, forerunner of the modern punched card and tape controls.

Theoretical analysis of control systems may be said to have started with a contribution[1] by J. C. Maxwell in the Proceedings of the Royal Society, 1868, "On Governors". In 1922 Minorsky published an analysis of the position control system of a ship steering engine, but modern closed-loop con-

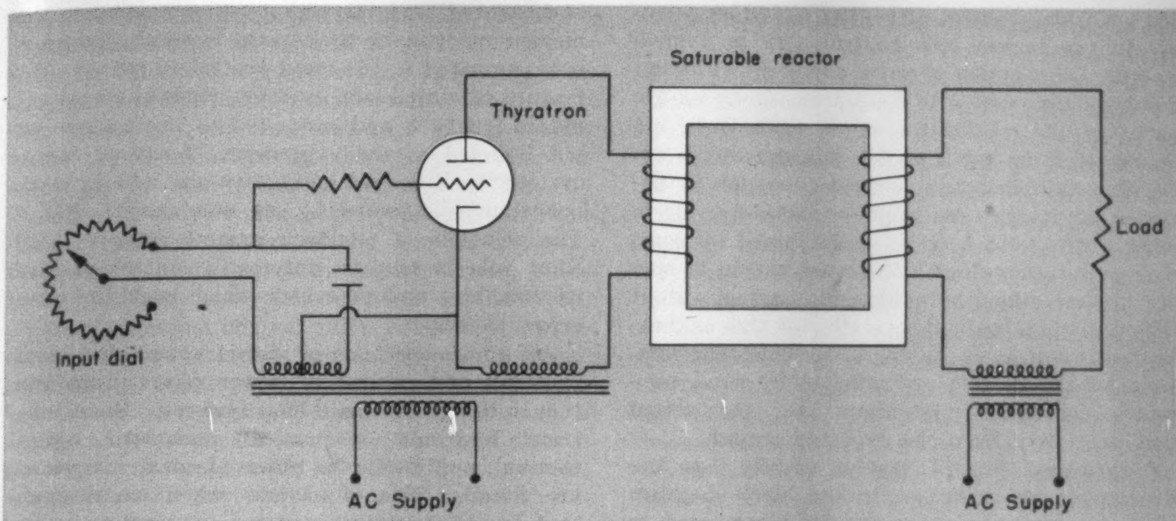


Fig. 2—Temperature controller for an electric furnace utilizing a saturable reactor. Input is the variable resistor of the thyratron grid circuit; output is heat loss in the furnace coil

trol did not really get underway until the decade of the 1930's. During that time attention moved from regulating to control of processes such as refining of oil and manufacture of certain chemicals. The first thorough treatment of servo theory was given in 1934 by Hazen, earlier work having been done by Nyquist who in 1932 first showed how stability could be determined in control systems.

During World War II, both in England and America, top-flight mathematicians and engineers conducted much secret work in the field of servomechanisms. Such systems were used for gun and searchlight remote-position control, radar scanners, rate control of gun turrets, aircraft flight control, and many other military applications.

Several years ago process control engineers, searching for answers to the more complex control problems posed by highly accelerated development of continuous processing methods, began to apply principles of feedback to industrial process control. The control engineer, adapting feedback control theory to his needs, developed new techniques, and applied these new techniques as tools in the newly recognized field of systems engineering.

Basic Principles Of Control

Applications of automatic control embrace a great variety of machines, plants and processes, and fresh applications are still being found. Higher standards of performance are necessary, particularly in more exacting applications. Consequently, it is necessary to have better understanding of control system behavior in order to assess the control possibilities of any particular application. Although applications range from piloting of aircraft to voltage regulation, from turbine governing to humidity control, a common basis of fundamental principles has been found.

Control of any variable whether it be temperature, flow, or gun position involves the transfer of energy through each component of the system. This flow of energy through physical systems may be written in differential equations based upon known physical laws. Therefore, system differential equations are fundamental in describing this performance and may be determined by an analysis based on experience and physical laws.

Because these equations describe energy transfer and are fundamental, many different devices may be mathematically combined into a system for control of a desired variable. Performance of a control system may be analyzed and studied before actual construction of the equipment begins. Unfortunately, these differential equations become complicated even for the simplest system, and their manipulation is difficult for the engineer. However, techniques have been developed based on well-known mathematical principles, which allow the performance of an automatic control system to be systematically studied. These techniques are known as feedback control theory, and through them the design of automatic control systems is rapidly becoming a science instead of an art.

Open and Closed-Loops

In any study of automatic control, two general classes of control systems are encountered, one called open-loop control, the other closed-loop control. In the former, the control acts in accordance with the dictates of some arbitrary quantity, and satisfactory action is dependent wholly on the linearity of the mechanism, or on calibration. In such a system an input signal or command is applied and amplified and a power output is obtained. Input may be applied manually, as in turning a dial, and may be accompanied by some sort of calibration chart. Expected output is normally predetermined by calibration; actual output obtained depends upon the validity of this calibration. Contingent upon the degree to which the components of the system are affected by time, temperature, humidity, lubrication, etc., the actual output may vary from the expected output.

An open-loop control system usually has the basic components indicated in the block diagram of *Fig.* 1. An example might be a temperature controller for an electric furnace arranged with a saturable reactor as shown in the schematic diagram of *Fig.* 2. Here the input is a variable resistor in the grid circuit of a thyratron and would be calibrated. In this example, the thyratron and saturable reactor act as amplifier and controller. Output is the power loss in the furnace coil, and the controlled quantity, or load, is the temperature of the furnace. Calibration is affected by tube aging, voltage variations in the ac source, physical condition of the furnace coil, and possibly by ambient conditions at the furnace location.

Closed-loop automatic control systems include the same basic components as open-loop systems, but also have additional features. Actual output is measured, and the signal corresponding to this measurement is fed back to the input station where it is compared to the input or desired output. This feature of closed-loop systems wherein actual output is fed back and compared to the desired output has led to the expression "feedback control system," and is used to signify any system whose operation is affected by its own output, *Fig.* 3. The principle of feedback control plays a significant role in modern automatic control—it gives us machines and processes which seek to correct errors in output.

All known methods of data transmission, measurement, and control of power receive consideration in design of closed-loop systems. Hence, electrical, hydraulic, mechanical, pneumatic, optical, thermal, and numerous other physical components are found. This is obvious when we recognize that feedback control systems are used to control temperature, pressure, flow, voltage, speed, position, and the like.

Examples of closed-loop control systems are numerous. These may be man-made, as in an industrial process, or may exist as an integral part of our everyday life. In a sense, the economic law of supply and demand is an automatic control system. Demand is the input, supply the output, and the difference causes prices to fluctuate up or down. Other feedback control systems are found in nature where regulatory type functions are performed. Control of human body temperature through the process of conduction, convection, radiation, and evaporation of moisture is an example of one of nature's feedback systems.

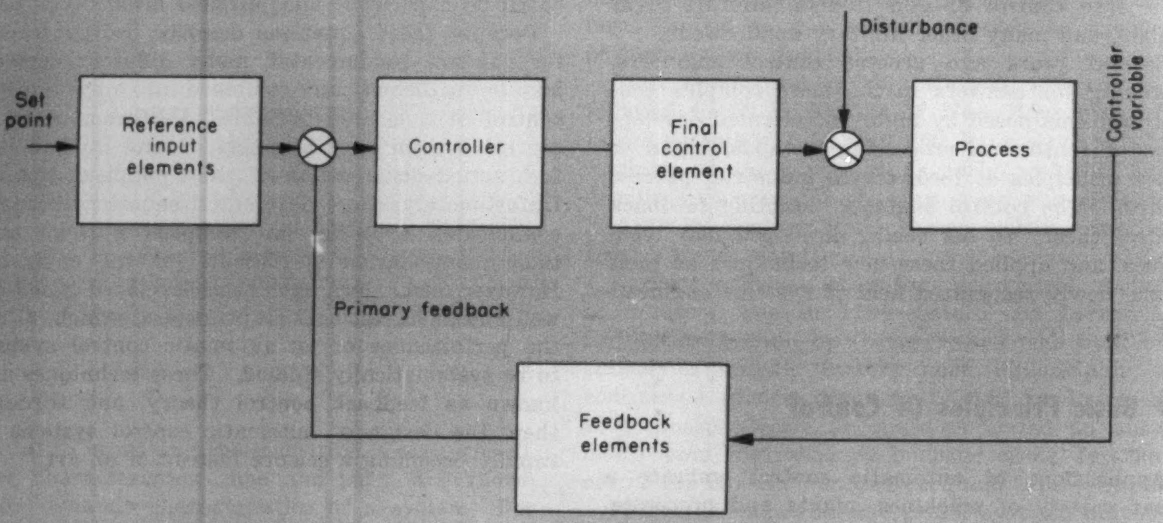


Fig. 3—Feedback control system showing functions usually found in the principal components. These systems are self-regulating, continuously and automatically readjusting for all conditions of disturbances

A feedback control system common to process industries would be control of product temperature by means of a heat exchanger, *Fig.* 4. Similarity of components in this system with those of the generalized system shown in *Fig.* 3 is evident. Here the set point of the recorder-controller corresponds to system input; position of the controller set point index corresponds to reference input elements; linkage of the recorder-controller correpsonds to the error measuring device; industrial pneumatic controller functions as the system controller; steam control valve is the final control element; heat exchange constitutes the process; and finally, temperature measuring element corresponds to the feedback element. A change in product input temperature would be a load disturbance. In general, nearly all closed-loop systems, regardless of their complexity, can be reduced to diagrams similar to that shown in *Fig.* 3.

▶ Stability and Accuracy Problems

Essential requirement of closed-loop control, as shown by these examples, is that the state desired and the state existing are continuously compared and any difference results in corrective action to minimize the error. A closed-loop system is an error-sensitive system and acquires certain peculiarities and idiosyncrasies which must be recognized in its design.

Basic principles of feedback control or closed-loop control tend to make for accurate performance since the control system endeavors to correct any error that exists. However, this corrective action can give rise to a dangerous condition of unstable operation when used with control elements having a large gain and significant delays in their response time. An unstable control system is one that is no longer effective in maintaining the controlled variable very nearly equal to the desired value. Instead, large sustained oscillations or erratic control of the controlled variable take place, rendering the control useless.

Requirements of stability and accuracy are mutually incompatible. The higher the desired accuracy, the smaller is the actuating error that can be tolerated for proper corrective action, and the sooner full corrective action must be initiated. If stable feedback control system performance is like that of a manually controlled system with a capable and well-trained operator, unstable feedback control system performance may be compared to that of the manually controlled system with an untrained and irresponsible operator. Rapid and destructive response of the system may result in the impossibility of adequate control. Stability of control of a variable by the selected control system then, offers a means to specify performance of the system. Stability along with system response time serves as a yardstick for measuring performance suitability of the automatic control system.

The physical picture of stability is essential and valuable to the designer. Mathematical definitions, however, provide more useful and exact means of

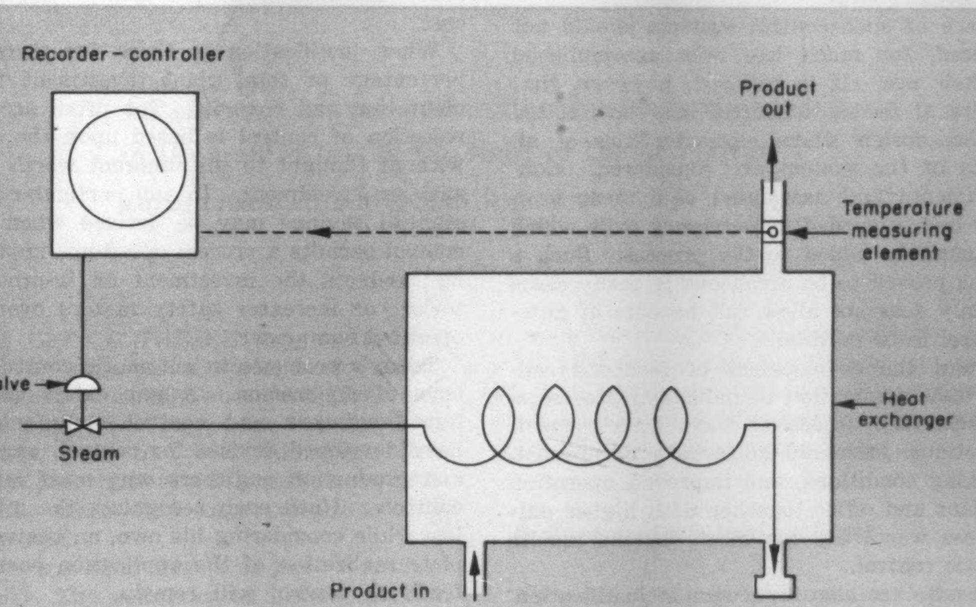


Fig. 4—Closed-loop system of a temperature control. Set point of the recorder-controller is the input; final product temperature is the output

describing system performance. This relationship is stated in the Nyquist criterion used in one form or another to determine system stability. Nyquist stability criterion places on a firm mathematical basis the known physical fact that, when the feedback signal to a control element is equal in magnitude and in phase with the actuating signal producing it, instability will result. The criterion establishes necessary conditions for stability in terms of the ratio between the sinusoidal actuating signal and the feedback signal.

▶ Criteria For Applications

It is one thing to understand theoretical concepts of automatic control, and quite another to put this knowledge to work. Recognition of areas which can benefit through application of automatic control is not always simple. By far the most common application of feedback control in process industries is the control of single process variables such as flow, pressure, temperature, and liquid level. Need for such control is usually based upon steady-state conditions, with control action establishing boundaries of process operation. Although the system controls the single variable to acceptable accuracy, such systems usually perform the function of preventing the process from operating at an undesirable level instead of actually controlling the operation of the process. Criterion for control is not based upon a system consideration of process operating characteristics, but rather on a material balance for some steady-state level.

Importance of such control systems should not be minimized, for much has been accomplished through their use. It is believed, however, that real benefits of feedback control may be realized from system design where characteristics of all components of the system are considered. Control instruments and associated equipment have sometimes been regarded as necessary evils which somehow must be added to the process. Such a concept has proved to be erroneous in many cases and certainly does not allow full benefits of automatic control to be realized.

Throughout the development of feedback controls and their application to industrial processes, several underlying objectives have been present. Cost reductions, increased uniformity of product, safer working conditions, and improved operation of both plant and office together with higher output and less waste are the most obvious results of automatic control.

These results are also its economic justification. If a plant cannot consistently make a quality product, it cannot sell it. If processing equipment is not properly designed and operated at near capacity, it is usually not possible to make a profit. The extent of realization of these objectives can be measured by our ability to increase continually the output of goods and services while at the same time decreasing the brute labor needed to produce these goods and services.

Economics of instrumentation are important to the systems engineer. How will the designer be able to accurately forecast monetary savings his company would gain from installation of a particular control system? Obviously it is impossible to calculate in every case the monetary savings which would result from added instrumentation. In some cases economic gains are obvious since the process could not function were it not for automatic control. For instance, it would be impossible to manufacture successfully such a new and widely used product as polyethylene, requiring coordination of many variables without the use of automatic control.

In other instances it will be practically impossible to place direct dollars and cents value on installation of a controller in an industrial process. Some benefits that result may be evaluated only by considering how much it will enhance the value of a production employee when he works more safely, has a double-check for accuracy and quality, and has the assurance that he is working with instruments and controllers which help him to do a job faster and more efficiently. These things cannot readily be assessed a monetary value, yet they are of tremendous worth and more than offset installation cost of most instrumentation.

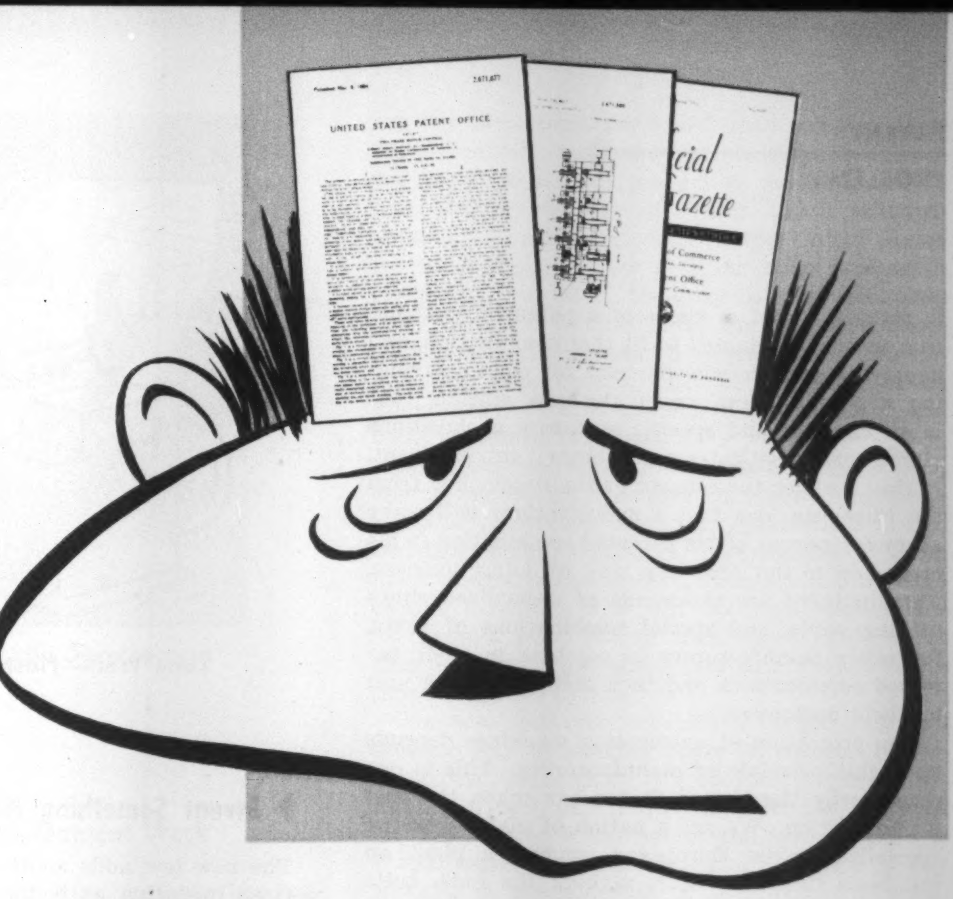
At one time instrumentation represented 1 or 2 per cent of the total capital investment; recently this has risen to 5 or even 10 per cent, and there are indications that within the next decade as high as 20 per cent will be so earmarked. In fact, in many chemical plants the instrumentation cost already amounts to 20 per cent of the total plant cost.

What justification is there for increasing the percentage of total plant investment for instrumentation and control? Too often acceptance or rejection of control is based upon the direct cost without thought to the inherent worth of making such an investment. In any particular plant, substantial savings may be derived when automatic control permits a process speed-up; improves quality; reduces the investment on in-process inventories; or increases safety factors over manually operated equipment.

Today's problems in automatic control are problems of application. A gap exists between systems engineers and control manufacturers who have developed devices for control, and managers and production engineers who must make use of controls. Until each recognizes the other's problem while considering his own, an obstacle to complete realization of the application possibilities of feedback control will remain.

Subsequent articles of this series will expand on the fundamentals introduced in this first article and illustrate their application with specific examples of automatic control systems.

By **H. A. TOULMIN, Jr.**
Toulmin and Toulmin
Attorneys at Law
Dayton, Ohio



PATENT PROBLEMS IN AUTOMATION

An eminent lawyer and writer discusses revisions in the patent law in the light of the growth of automation in American industry

PATENT OFFICE THINKING prior to 1953 was still in terms of a workman for every tool. The concept of a fully automatic plant was alien to the patent philosophy of the Patent Office. In most courts, rules had been laid down that would destroy patentability of a fully automatic machine. While there were some exceptions, this was generally true.

The old rule was that there was little invention in automaticity. The courts often decided that a group of machines or parts of machines, automatically operated in sequence, were not invention —but mere "aggregation", i.e., the sum of the parts of machines was no different from the total of their results operating independently.

In 1953, when the new Patent act went into effect, a wholly new concept of invention, as applied to modern production from the patent law point of view, was put into force.

▶ Contributory Infringement

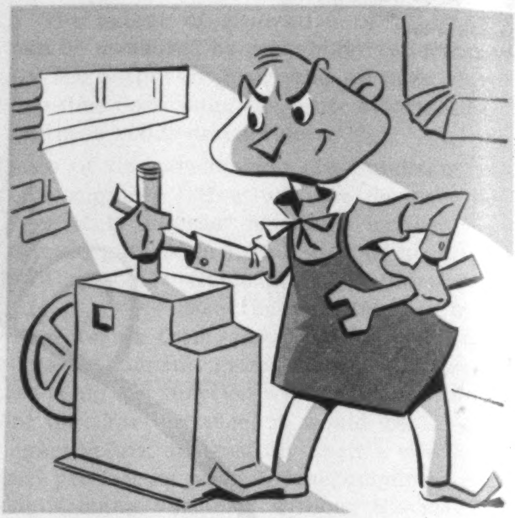
This new law first reversed the Supreme Court policy of the United States in its holdings over a period of twenty-five previous years which gave the patentee no protection against acts of contributory infringement. Contributory infringement is making a part or parts of a patented combination especially adapted to fit that combination, and supplying same to someone else for use in infringing a patent. Now, under the new statute, that is all changed and specific statutory declarations state what constitutes contributory infringement.

This changes the concept of the Patent law from the European idea that a manufacturer will make every component of his patented combination in his own shop to the American way of doing business, wherein there are thousands of specialized shops making parts, and special combinations of parts, for other manufacturers to combine in their patented combinations and then ship them as a unit to their customers.

The protection of automation machines depends upon this principle of manufacturing. This is one reason why the United States has taken the lead in automation. We are a nation of manufacturing specialists, while Europeans conduct a plant on the basis that they start making the nuts, bolts and screws with the apprentice boys in the apprentice shop, make their own castings, many of their own tools and every part from motors to set screws, in their own shop. Obviously such an organization never achieves the economies of mass production which we have in the United States.

Now the law in the United States is changed to recognize our way of doing business. Before this new law, if you did not manufacture the entire construction, then you failed to get protection against those who were supplying others with components specially designed to fit your combination and, in doing so, were bringing about complete infringement.

Invent Something New



Lone Wolf—Flash of Genius

Invent Something New

The new law adds another important aspect. It defines invention as being that advance which is not "obvious" to one who has "ordinary skill in the art". It must, of course, be new and useful.

This means that the Patent law is no longer only technical—it rewards a genuine, constructive advance in the public interest. The era of electronic controls, of mathematical computing machines and automatic controls for processing machines, as well as for the control of chemical processes, has helped bring about an entire new concept of the dignity of invention.

Courts are human. They are impressed with an invention that does everything a man can do and do it better, do it automatically, tirelessly and with precision and accuracy. Its components may be old, but that is still invention if the composite machine shows inventive concept, novelty and utility, and produces a new or improved result greater than the mere sum of the components.

The very spectacular nature of automation is going to impress the courts and open up wholly new areas of protecting invention.

As automation is often the sum of many brilliant brains producing components under the guidance of a general staff mind directing the assembling of components in precise battle order to attack a complex problem, it eliminates unnecessary hand operations and reduces costs. The very magnitude of the task and the brilliancy of its performance will impress the courts. This is indicated by the way courts, even under the old law, protected complex machines like heel seat lasting machines[1] and other similar complex machines in the cash register[2], typewriter and machine tool fields. Increase in speed has been recognized as invention.[3] Precision manufacturing controls have been found to be invention by the Supreme Court.[4]

---

[1] References are tabulated at end of article.

Group Research and Development

▶ Research and Development Work

The new Patent law has introduced another very helpful provision to automation, again reversing Supreme Court policy. Prior to this law, the Supreme Court in recent years was tending toward the position that only the individual inventor working by himself in his cellar or shop could be an inventor. This was a direct attack upon mass engineering departments and large research organizations for automation in electronics, chemical and mechanical matters where a complete staff is necessary to developments. The 1952 law (effective January 1, 1953) has sharply repudiated this doctrine of the individual being the only inventor as inconsistent with the American way of doing business.

The day of the individual inventor and the lonely scientist is rapidly fading and Congress recognized it by inserting in the statute these words, authorizing patents on inventions made in large research and development organizations:

> "* * * Patentability shall not be negatived by the manner in which the invention was made." (35 U.S.C. s 103 (1952).)

This means that a company can get patents that are the result of multiple inventors or research men working under the co-ordinated direction of great engineering departments and distinguished research organizations. It is recognition that American principles of scientific teamwork and the vast integration of engineering principles in modern laboratories are just as important a part of modern industry as American mass production and sales.

It is recognition of the first principle that you must have a great many specialist manufacturers and specialist engineers, inventors and research men, each contributing his part, to have the modern age of automation based upon complex processes, controls, mathematical calculations and intricate, split second, production machinery.

It is Congress' way of saying that it acknowledges how business is done in the United States by modernizing the law to fit our mass production civilization. In effect, Congress says, it recognizes that companies in the United States must be specialists and their research organizations and engineering departments must be composed of an integrated body of specialists to create, design and make automatic machines.

But Congress went further. It now holds that, due to the rapidly changing turnover in engineering departments and research organizations in this turbulent country of ours, inventorship is, first, hard to determine; second, there are a few recalcitrant inventors who will not sign applications for patents even though they agree to do so or they drift away and cannot be found when it comes time to sign the papers.

The new 1953 law provides a unique and very sensible way of meeting these situations. It provides that where there is a contract requiring the signing of such papers, the employer may sign for the inventor or a partner of the inventor who is a co-inventor may sign for him. If there is any mistake in the selection of the inventors, which frequently happens in complex, mass production organizations, you can change the inventors before and after the patent is issued.

We are entering an age where the inventions are of a much higher order of talent, knowledge and skill because we have great scientific and engineering talent and the inventions are increasingly more complex because the brains of such men are capable of advanced thinking in complex machines. Such inventions are necessary because of the mass production demands which are beyond human strength, accuracy and reliability. The

Security Through Secrecy

cost of man-hours in factories has risen sharply while the number of hours worked has descended.

▶ Security by Secrecy

Only talented inventive genius of our mass production economy can meet this economic challenge. The new law takes notice of this and is adjusted to meet it.

It also perceives that much of what we do defends us and secrecy may become important. To meet this, the new Patent law has strict rules of secrecy which can be enforced by the government and the Patent Office. Provisions are made for compensating the inventor whose patent application is impounded to protect the national interest.

You cannot ship inventions abroad until after the patent application has been pending for six months in the United States Patent Office and then you must have a license to file applications abroad. There are various other security provisions not only in the new Patent law but in the new Atomic law.

In the field of atomic energy where automation is a basic consideration, the new Atomic law has now been modified to recognize that private interests will be granted patents except in the field of weapons and restricted areas in the national interest.

You may be required under compulsory license to share your ideas, but the entering wedge has been put into the Atomic law to permit commercial interests and individuals to file applications for patents and get patents on atomic matters unless the applications are in conflict with the national interest.

This opens the doors to tremendous expansion of industry, engineering, science and mass production with new sources of power beyond the concept of man. Great power and energy depends for its controls on advanced automation — its dangers force this and its powers are beyond human control.

Congress has wisely decided to follow the American idea of permitting private interests with all their vigor and wealth, to push forward these new frontiers of science, invention and engineering, particularly in atomic plants, and to take the brakes off the industrial vehicles so that we can write a new chapter in the industrial history of the world.

▶ Modern Laws

This statesmanship of Congress, set forth above, recognizes how we do business in the United States and casts aside the old laws that were tied to the way business was done in 1880. Now the laws are based on business as it is done today.

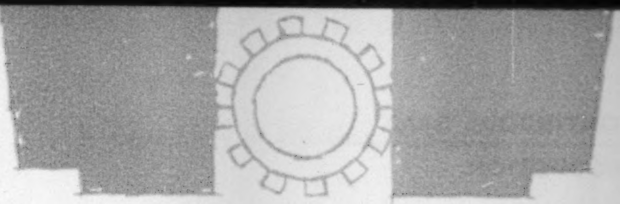
The United States with its high labor costs must secure low labor costs per unit with automation. As to European competition, the best guarantee that our industry can compete with its low labor costs will be automation. As Europe adopts automation, and raises wages, the prosperity of the world will increase in great measure because all countries will be able to raise labor rates and meet the challenge of the necessity for higher scale of living with shorter hours. This is the best guarantee of peace in our time while providing a sound economy for the United States.

REFERENCES

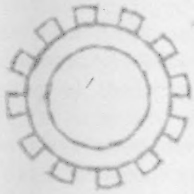
1. Williams Mfg. Co. v. United Shoe, 316 U.S. 364.
2. Remington Cash Register Co. v. National Cash Register Co., 6 F. (2) 585.
3. Mineral Separation Ltd. v. Hyde, 242 U.S. 261.
4. Eibel Process v. Paper Co., 261 U.S. 45.

NEW LAWS
OLD LAWS

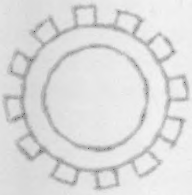
Legislation Keeps Pace With Progress



By C. E. SCOTT
Chief Engineer
Michigan Tool Co.
Detroit, Mich.



VERSATILITY ACCENTUATED IN CONTINUOUS GEAR PRODUCTION



Complete redesign of production equipment is often thought the only resort in achieving total automation—but consider the practicability, versatility and extended appeal of automation resulting from the application of accessories to existing basic machines

OBVIOUS ADVANTAGES of automated gear production might make it appear that installation of completely automatic lines would be good practice for all gear producers. Typically, though, this is a practical solution with definite advantages only in those cases involving high production of a single gear. It is noteworthy, however, that the methods of total automation are of interest to all size producers because of the potential partial automation available by the intelligent use of selected components found in the continuous production line.

▶ Continuous Quality Control

Tooth-forming phase of gear production to be covered in this article involves hobbing or shaping (rough machining), shaving (finish machining) and speeding (running quality test). The discussion can well begin with quality control of these operations since the heart of a fully automated system is the continuous inspection and classification of gears at several points in the production line. Automated quality control gear gaging installations consist of three basic units:

1. A 3-way gear classifier which automatically separates gears into correct size, scrap (undersize) and salvageable (oversize) categories.
2. Control panel which operates in conjunction with the cyclic controls of the basic machine and is capable of either stopping or adjusting the machine.
3. Actuating mechanism for adjusting center distance between the cutting tool spindle and the work spindle. This mechanism compensates for cutting tool wear and thermal expansion or contraction in machine parts.

Primarily, these units control the hobbing and shaving operations, *Fig.* 1. Considered as an entity, information from the classifier feeds back through the control panel to actuate the adjusting machanism. This adjustment is automatic where any given number of undersize or oversize gears are produced in succession; should only one gear register oversize at the classifier, there is no adjustment. With this method, center distance between work and cutting tool is kept constant and needless adjustment avoided. Should it be more practical for a particular application, the machine can be shut down automatically rather than have center distances adjusted.

Three basic types of gear classifiers are available:

1. Gravity type, *Fig.* 2, in which gears roll down a chute between a constantly rotating master and stationary master gear.
2. Conveyor type, *Fig.* 3, in which gears are carried on end by a horizontal conveyor belt between two master gears, one of which revolves constantly.
3. Rotating type, in which the gears are automatically mounted on an expanding mandrel and rotated in mesh with a master gear.

Each gear classifier is custom made for one particular gear. The component parts such as motor, limit switches, timers, etc., are standard to assure maximum ease of maintenance and service. As has been stated, the gear classifiers are capable of automatically separating good production from over and undersize gears. An unsatisfactory gear passing between master gears actuates a limit switch which controls deflection of a gate. Scrap and salvageable gears are directed to separate containers; good production passes through the classifier. Gravity and rotating types will check gears for plus or minus deviation of helix angle in helical gears. In addition, the rotary type can check gears for eccentricity. The conveyor type classifiers are especially suitable for large, long or cluster gears which do not lend themselves to rolling down a chute, or to small gears where it is desirable to maintain the checking operation on a horizontal plane with no loss of height between operations.

▶ Classifier Application

While any of the three types of classifiers will maintain 100 per cent quality control of the gear cutting and finishing operations, they are not intended to replace the periodic sampling inspections with normal gear inspection instruments.

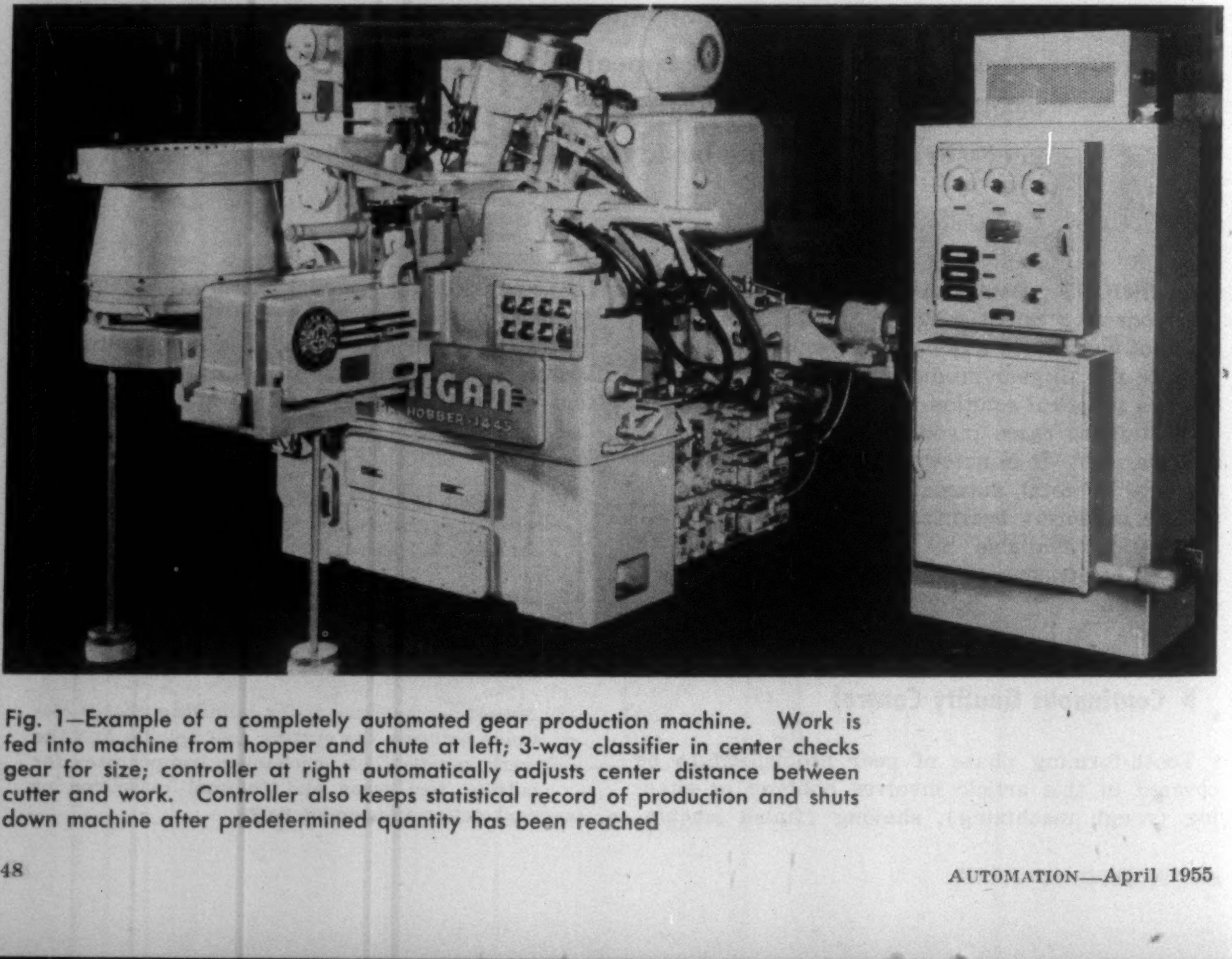


Fig. 1—Example of a completely automated gear production machine. Work is fed into machine from hopper and chute at left; 3-way classifier in center checks gear for size; controller at right automatically adjusts center distance between cutter and work. Controller also keeps statistical record of production and shuts down machine after predetermined quantity has been reached

Such things as involute contours, tooth to tooth and cumulative tooth spacing, tooth crowning and lead checking must still be controlled in the gear inspection room.

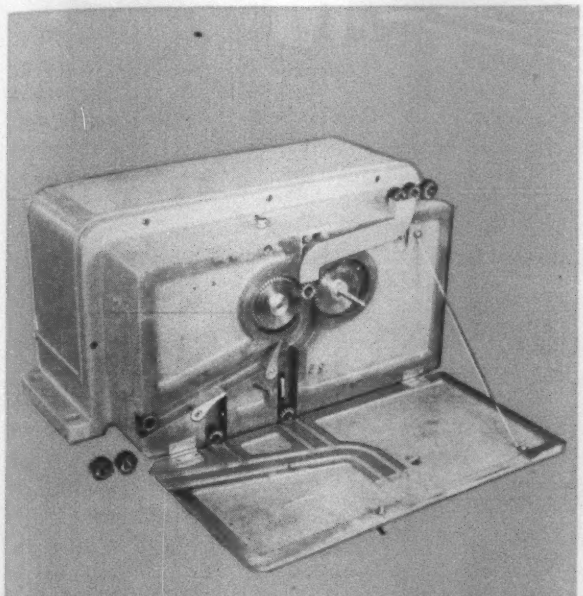


Fig. 2—Internal chute in gravity type classifier directs work between stationary and rotating master gears. Reaction of work with master gears provides signal source that actuates gate, shunting salvageable and scrap gears into different receptacles

The fully automated gear production line requires at least two classifiers—one working in conjunction with the gear cutting machine and one with the shaving machine. In classifying gears after cutting and before shaving not only is there complete inspection with elimination of human error but also a material improvement in life of shaving cutters. At best, shaving oversize gears shortens cutter life and in extreme cases broken cutters can result. An improvement in cutter life is readily translated into significant savings by the company that produces large quantities of gears.

Use of a gear classifier as a separate unit without automatic control of center distance actuating mechanism is more desirable for some installations. For instance, where a battery of shaper cutters or hobbers are producing the same gear, one gear classifier can gage all the gears produced by as many as 12 or 14 production machines, *Fig.* 4. In this case, if a rotary classifier were used, gears could be checked for eccentricity, size and helix angle. Indication lights would show if gears are satisfactory or exactly what is wrong. Separating the gears according to the machine which had performed the operation would enable manual adjustment of the machine in error.

▶ Gear Shaving—A Good Example

An understanding of the other components necessary for a completely automatic line can best be developed around a description of one particular machine operation. The shaving machine is chosen because historically the start of automation can be attributed to improvements in tailstock and centers of this machine.

Gear shaving is a high-speed process compared to hobbing or shaping and, as has been mentioned, one shaving machine can handle the output of several forming machines. Perfect balance between number of shaving and hobbing machines cannot be achieved in every installation. In striving for more production and balance, an effort was made to cut down the cycle time of the shaving operation by decreasing the loading and unloading time. In 1947 the first air-operated tailstock and centers were installed on shaving machines for automotive plants. This was the starting point for the automation of all types of gear production machines in that it provided the key to development of automatic loading devices.

With only the addition of the air-operated centers, it was possible for an operator to handle an additional machine or to perform some additional production or inspection task through the time saved in loading and unloading. Since this filled the needs of higher production from the shaving machines, further development moved along somewhat slowly. In fact, it has taken approximately seven years to reach the point where completely automatic machine installations are underway. Hence, today there are a large number of shaving

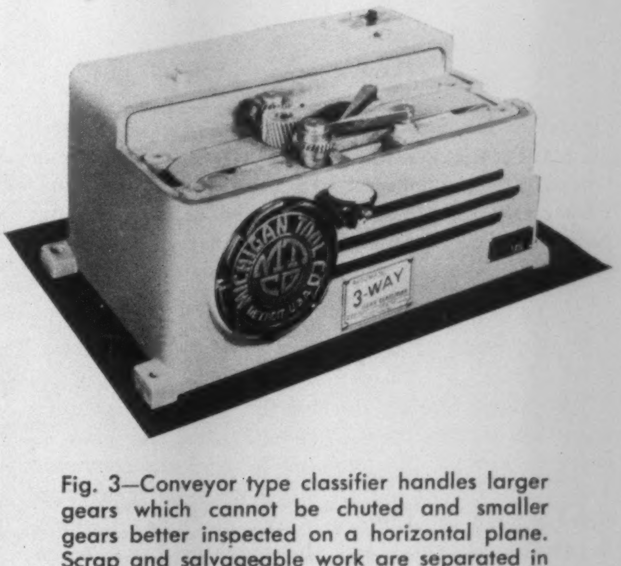


Fig. 3—Conveyor type classifier handles larger gears which cannot be chuted and smaller gears better inspected on a horizontal plane. Scrap and salvageable work are separated in same manner as with gravity type classifier

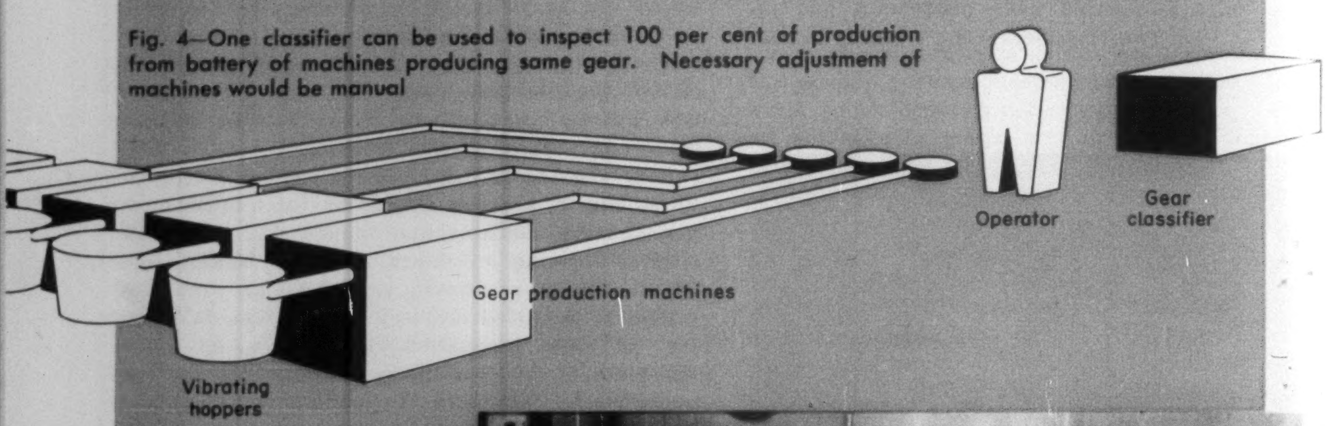


Fig. 4—One classifier can be used to inspect 100 per cent of production from battery of machines producing same gear. Necessary adjustment of machines would be manual

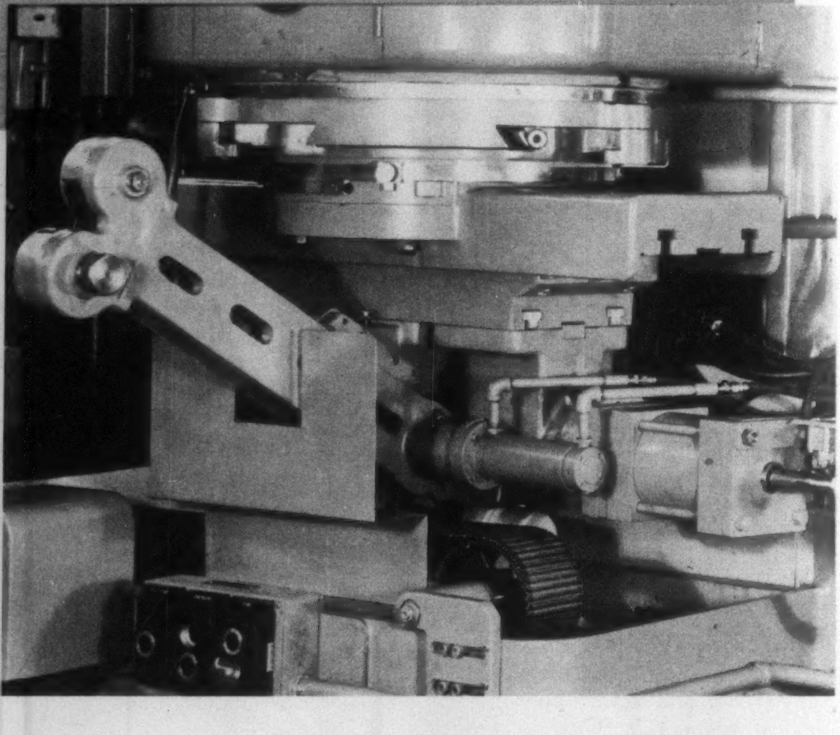


Fig. 5—Loading chute equipped with sizing fixture to prevent entry of oversize work. Air cylinder at bottom of chute transfers work into holder for actual machining process. Machine will automatically shut down after processing last gear in chute

machines in operation that do not have air-operated tailstock centers. This is particularly true where these machines are used for short runs. Practically all of the air-operated tailstocks have been used on shaving machines for one type of gear.

▶ Methods of Loading

Automatic loading devices for shaving machines have taken two forms. In one case the gear is carried through the machine by a chain conveyor which indexes so that it stops with the gear suspended near the centers of the machine. Centers automatically close and the machine cycle takes over. When the cycle is completed the centers are automatically retracted and chain conveyor indexes to the next gear. This type of conveyor may be used to index through as many as four machines for shaving of a cluster gear which would require a separate machine for each gear. With this arrangement, the operator merely loads and unloads the chain conveyor at some convenient point and watches over the operation of his battery of machines. Use of cluster gears is declining with the advent of automatic automotive transmissions so there have not been many installations of the conveyor type.

The second type of automatic loading device, and by far the most popular, is the gravity conveyor. Its form is that of a chute which is loaded with gears as they come from the hobbing or shaping machine, *Fig.* 5. It is possible to use a sizing fixture on the ends of these chutes to prevent oversize gears from being fed to the shaving machine. These sizing chutes are now being replaced by gear classifiers which also eliminate undersize gears. Importance of controlling size of all gears prior to shaving has already been pointed out.

Loader Operation

Typical gravity type Michigan loader is shown in *Fig.* 5. This loader meets requirements of compactness and simplicity of design. Gears travel down the chute and are transferred into a holder by means of an air-operated cylinder. This action pushes out the completed work in the holder. As the shaved gear leaves the fixture, it actuates a limit switch causing the next gear to be moved into mesh with the shaving cutter and the centers are advanced for a new cycle.

The holder is designed so that a gear may freely rotate. With this arrangement, meshing of the gear and cutter is practically a certainty. However, should a gear fail to mesh with the shaving cutter and the tips of the teeth ride on top of the tips of the cutter teeth, the work is automatically retracted in its holder and a second pass is made. This process is repeated automatically until the gear and cutter mesh so that it is impossible for a gear to pass through the feeding mechanism and not be shaved. At the end of a cycle, shaving centers are retracted and holder returns to the loading position; when the last gear in the chute has been shaved, machine is automatically stopped.

Shaved gears leaving the holder drop onto a chain conveyor and are carried to a tray or to another conveyor, or they may be chuted directly to a classifier, *Fig.* 6. If an automatic classifier is installed before the shaving machine, it is good practice to incorporate a vibrating hopper with the chute loader. Hopper feeding can be controlled with an electric eye which operates the hopper only when the chute is empty.

While chute fed automatic holders were developed for small compact gears, their use has been extended to such gears as the flange type, shown in *Fig.* 7, and those with extended hubs. Wide, unbalanced gears can be handled readily by the use of supports and guides at some balance point along their length. At discharge these forms can be deflected over on end for belt conveying.

Gear Hobbing

Gear hobbers may be equipped for automatic loading in a manner practically identical to that employed with the shaving machine. Use of air-operated tailstocks has been limited but gear hobbing machines of the latest design offer such centers as a standard feature. Generally, only the gravity type automatic holders have been used with hobbing machines. A typical installation is shown in *Fig.* 8. In this setup small-diameter, wide-faced helical gear blanks are vibrated in a hopper endwise and brought into position to roll

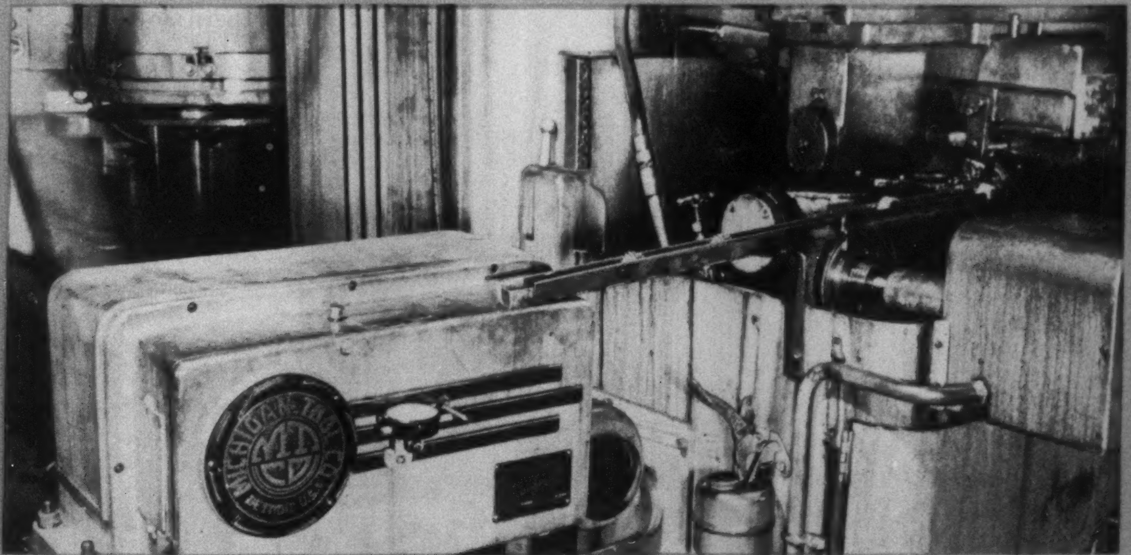


Fig. 6—Finished gear is directed from shaving machine to a 3-way classifier. Classifier of this type can automatically shut down machine if a gear fails to pass satisfactorily to allow for manual adjustment of machine

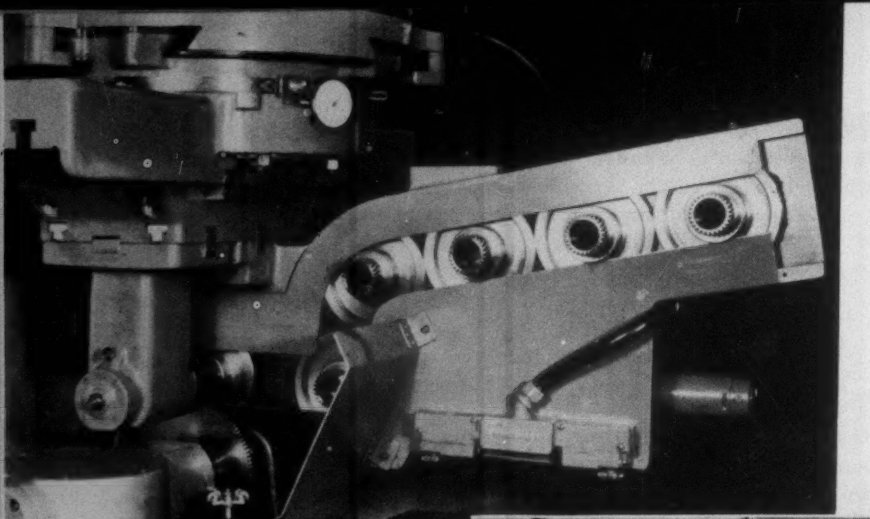


Fig. 7—Flange gear being loaded by chute and positioned between centers. Other forms not obviously suited to chute feeding can be similarly handled by use of supports and guides at some balance point

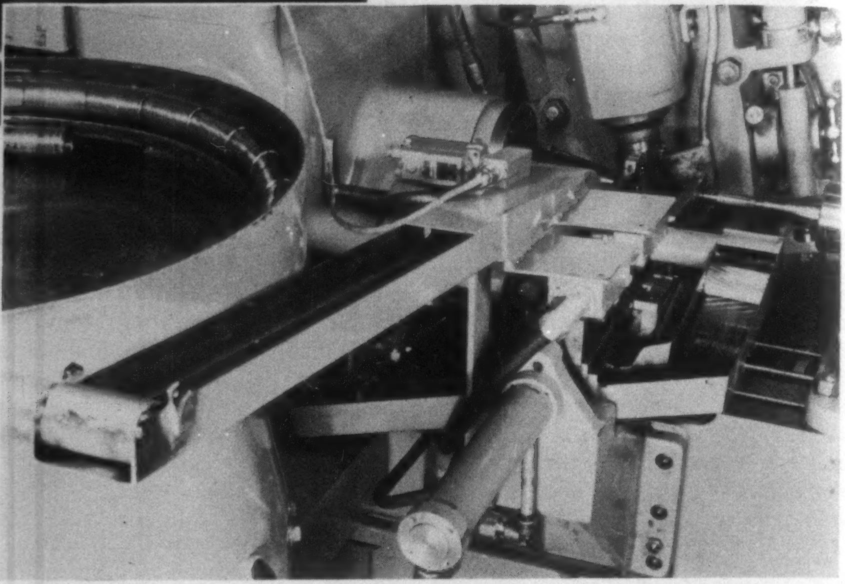


Fig. 8—Typical hopper fed chute arrangement for hobbing or shaving machine. In this illustration blanks are being fed into chute for transfer into holder by means of pneumatic cylinder. Outgoing chute directs finished work to next operation

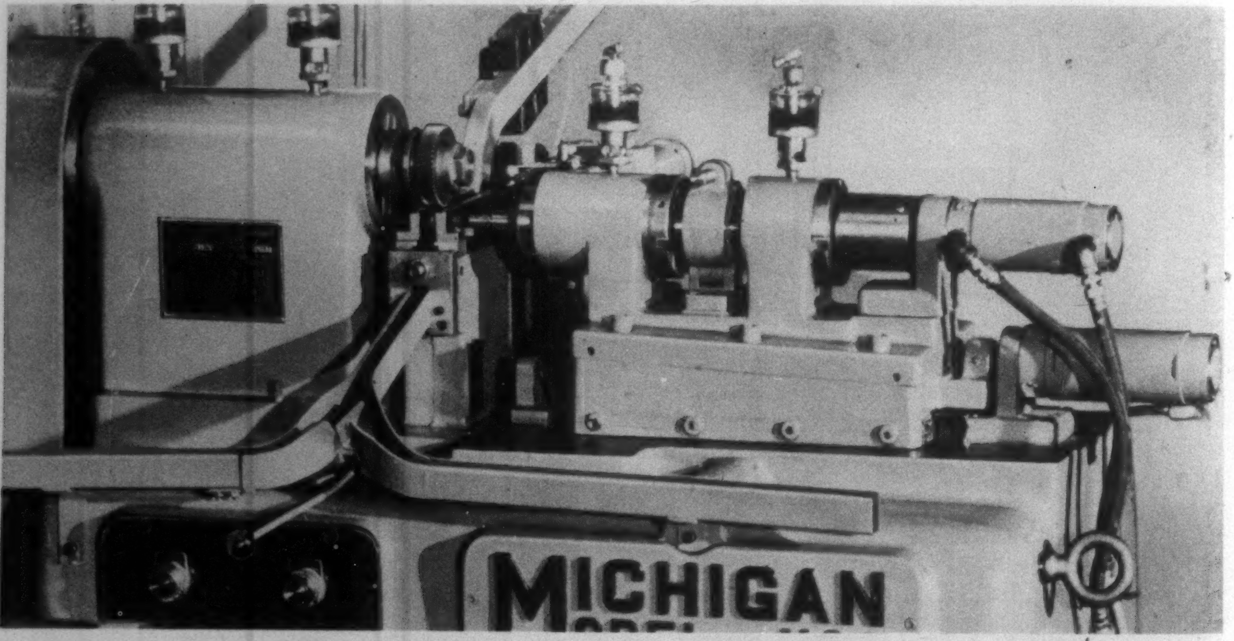


Fig. 9—Gears are accepted or rejected at this machine according to volume of sound produced when speeded in mesh with mating gears. Electric eye in chute controls hopper separated by partition from speeder. Chute in foreground routes gear into acceptable or reject receptacle

down the chute. Method of loading between centers is the same as with shaving machines with the exception that the opening in the holder is adjacent to the hob to provide clearance for the hobbing operation. Hobbed gears are passed through a classifier which stops the machine for manual adjustment or automatically controls center distances in those cases involving unsatisfactory production. Good production is discharged onto a conveyor or into a container for transfer to shaving operation.

▸ Gear Speeding

Use of air-operated centers on gear speeders is an innovation just beginning to come into use. In fact, this is one instance where the air-operated center and complete automation are being adapted simultaneously for production of critical small gears for automatic automotive transmissions. Hopper loading of speeding machines is just as practical as with shaving or hobbing machines. Since gears are accepted or rejected at speeder testing according to volume of sound produced when speeded in mesh with mating gears, it is necessary to separate vibrating hoppers from gear speeders by a soundproof partition, *Fig.* 9. This eliminates any confusion in sounds that result from the noise of the vibrating hopper. Hopper feed is controlled by an electric eye. Loading and unloading of the gear and operation of the speeding cycle is automatic. Operator decides by sound at test whether or not gear is satisfactory. After deciding, he flicks a lever to route gear to accept or reject receptacle and new test cycle begins.

▸ Plus Advantages of Automation

As is often the case, continuous production has brought benefits beyond the original concept of simply an increase in production at lower costs. One bad gear is too many; use of a classifier for 100 per cent inspection of production has shown that a great many more undersize, oversize, plus or minus helix and eccentric gears are passing present quality control systems than was thought possible. From the economic standpoint, there is improvement in cutter life and machine time saved by not extending mistakes in performing additional machining operations on parts which fail to meet specification at the outset.

THE AUTHOR

C. E. Scott has been associated with Michigan Tool Co. for 20 years. His appointment as chief engineer has been recently announced. With a background in both service and engineering departments, the author has been intimately connected with development and application of gear production machinery of all types. His particularly broad experience in automatic gear production parallels Michigan Tool Co.'s pioneering developments in this area ranging from automatic feed on single machines to completely automatic lines.

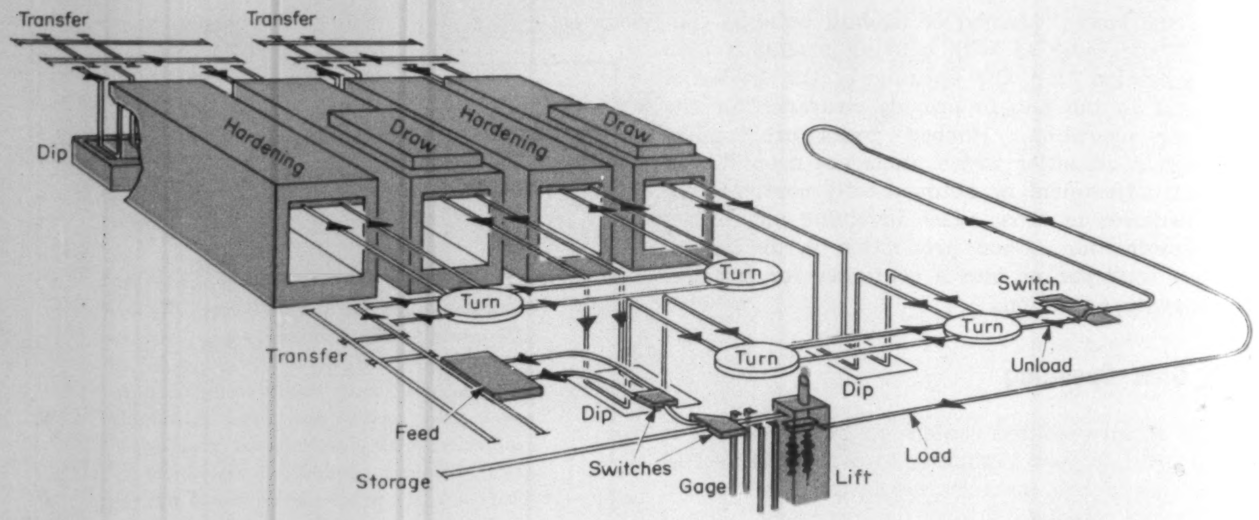
SHORTAGE OF WORKERS

FOREMEN believe the key to America's future of industrial prosperity is automation and its continued growth. We are concerned with the growth of foremen as management men, but we have no fear that tomorrow's foreman will be an "electronic" foreman. Neither do we believe that a foreman will supervise "electronic" workers.

Perhaps tomorrow's foreman will be more concerned with automatic machine maintenance than he is with physical production, but he still will supervise people. Perhaps also the people supervised will be concerned primarily with servicing automatic machines, or with building automatic machines.

We believe automation will bring about a new type of skilled employee, that our public schools, colleges, universities are doing splendid jobs of turning out better-educated people to handle the more skilled jobs in our industries. Automation will cause our general living standard to rapidly improve and the public demand will be for a greater number of more varied products than ever before in our country's history.

This increased consumer demand for all kinds of items concerned in our daily living will cause employment to gradually climb to where within ten years we may encounter a shortage of working people to man our factories.—*Dean Sims, National Association of Foremen.*


Transfer
Transfer
Dip
Hardening
Draw
Hardening
Draw
Turn
Turn
Switch
Turn
Unload
Transfer
Turn
Dip
Feed
Dip
Load
Storage
Switches
Gage
Lift

CONVEYOR SYSTEM AUTOMATES

HEAT TREATING OF CRANKSHAFTS

CONVEYORS often encompass more than the mere moving of parts in advanced automation installations, and are now an integrated part of most modern manufacturing or process operations. The automotive industry has capitalized on these developments which integrate conveying operations with automatic transfer and positioning devices.

Heat treating operations on crankshafts at the Dodge Forge plant, *Fig.* 1, are co-ordinated by such an integrated conveying system designed and installed by the American Monorail Co. Crankshafts are suspended vertically from conveyor carriers after they are forged (See AUTOMATION, March 1955) and are elevated by an air hoist to a furnace-entry position or a storage bank.

Carriers enter the gas-fired hardening furnace, *Fig.* 2, at intervals of just over 3 minutes and pass through the furnace in 100 minutes, raising the temperature of the forging to 1550F. After emerg-

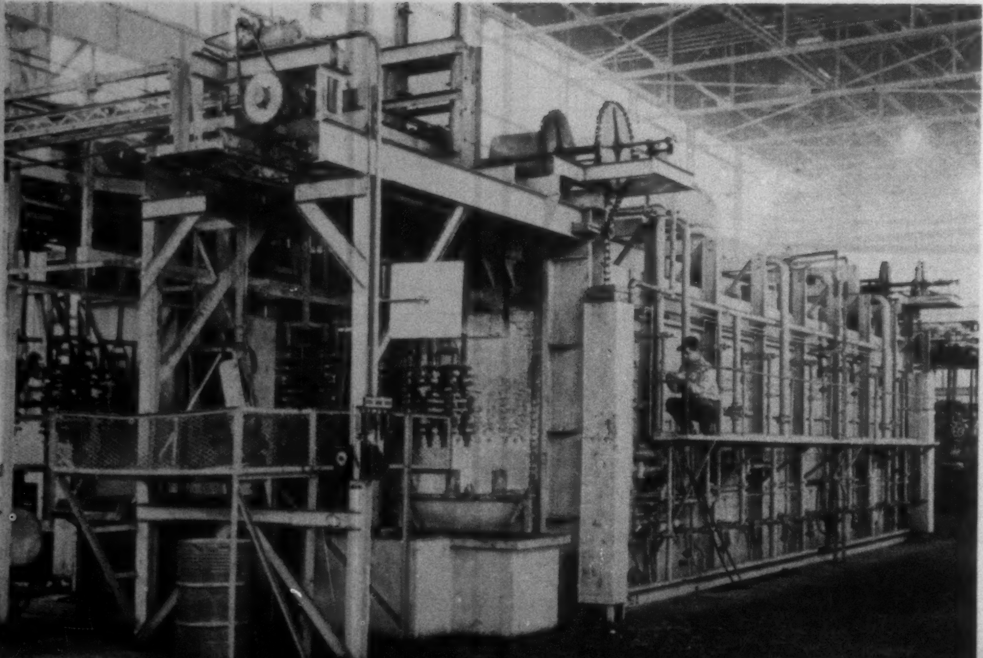
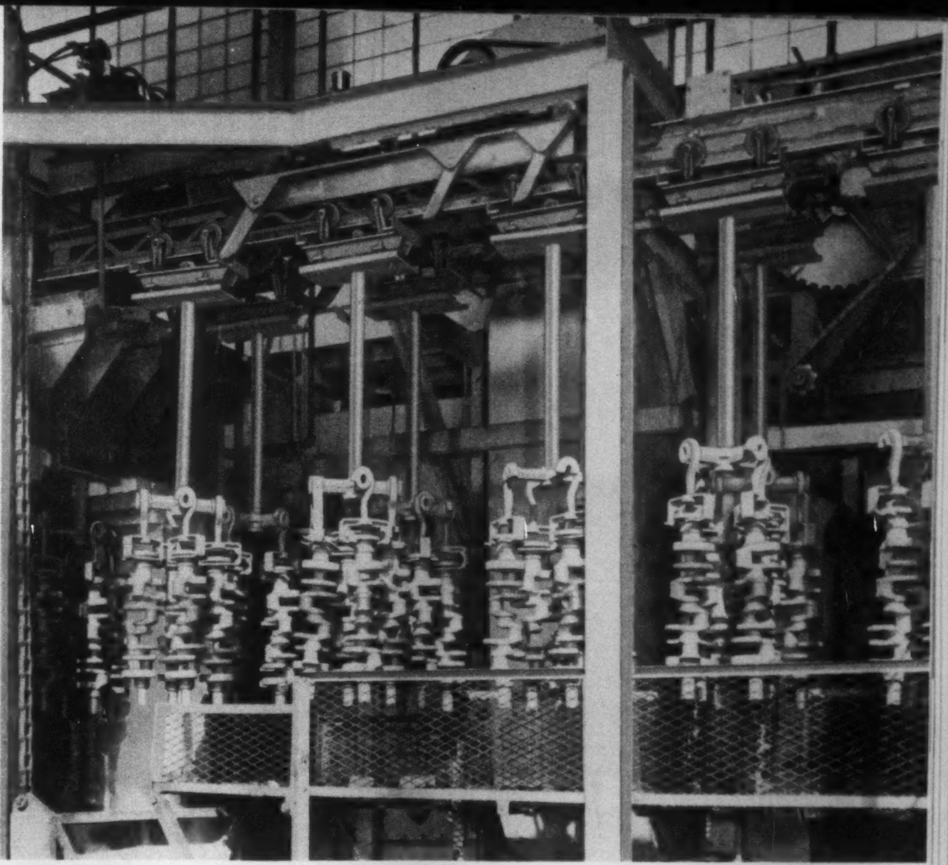


Fig. 1—Overall view of the Dodge Forge plant, heat treating installation showing crankshaft forgings emerging from the hardening furnace to be water quenched in the tank adjacent to the open furnace door. Forgings are processed on pairs of carriers, each carrier holding four crankshafts

Fig. 2—Crankshafts entering the hardening furnace after passing through a gaging device to insure concentric loading. The twin systems for hardening, quenching, and tempering enable a relatively slow process to match forging production rates



ing from the furnace, carriers are lowered to quench the forgings for 70 seconds in a tank of water, held at 90F, agitated to obtain optimum brinell hardness.

An elevator raises carriers from the quench and back to the monorail, *Fig.* 3, to be moved into a gas-fired tempering furnace, again at intervals of just over 3 minutes. Pairs of carriers, with each carrier holding four crankshaft forgings, move through the tempering furnace in 120 minutes—tempering at 1125F. After another water tank cools the tempered crankshafts, they are raised and returned to the monorail for movement to a shotblast cleaning process.

When shotblasting is completed, forgings are transferred with the aid of another air hoist to a conveyor which moves them to a center drilling operation for subsequent machining. After gaging and inspection for hardness and defects, the material is ready for shipping.

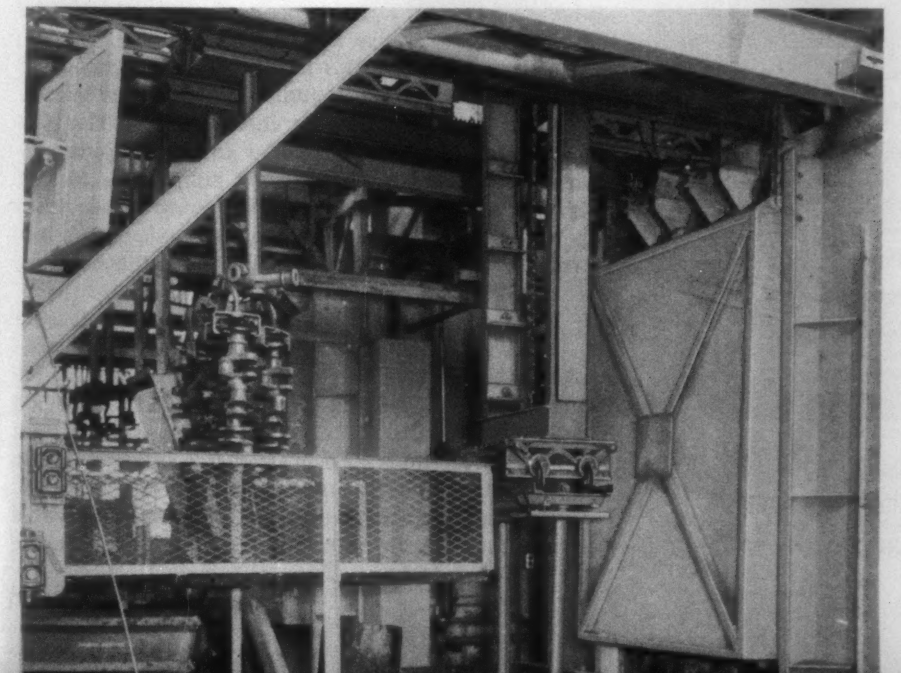


Fig. 3—Elevator used to lower and raise crankshafts when quenching. A section of conveyor track moves vertically with a pair of carriers. After quenching, the forgings make a *U* turn and move into the tempering furnace

SYSTEM CONTROLS

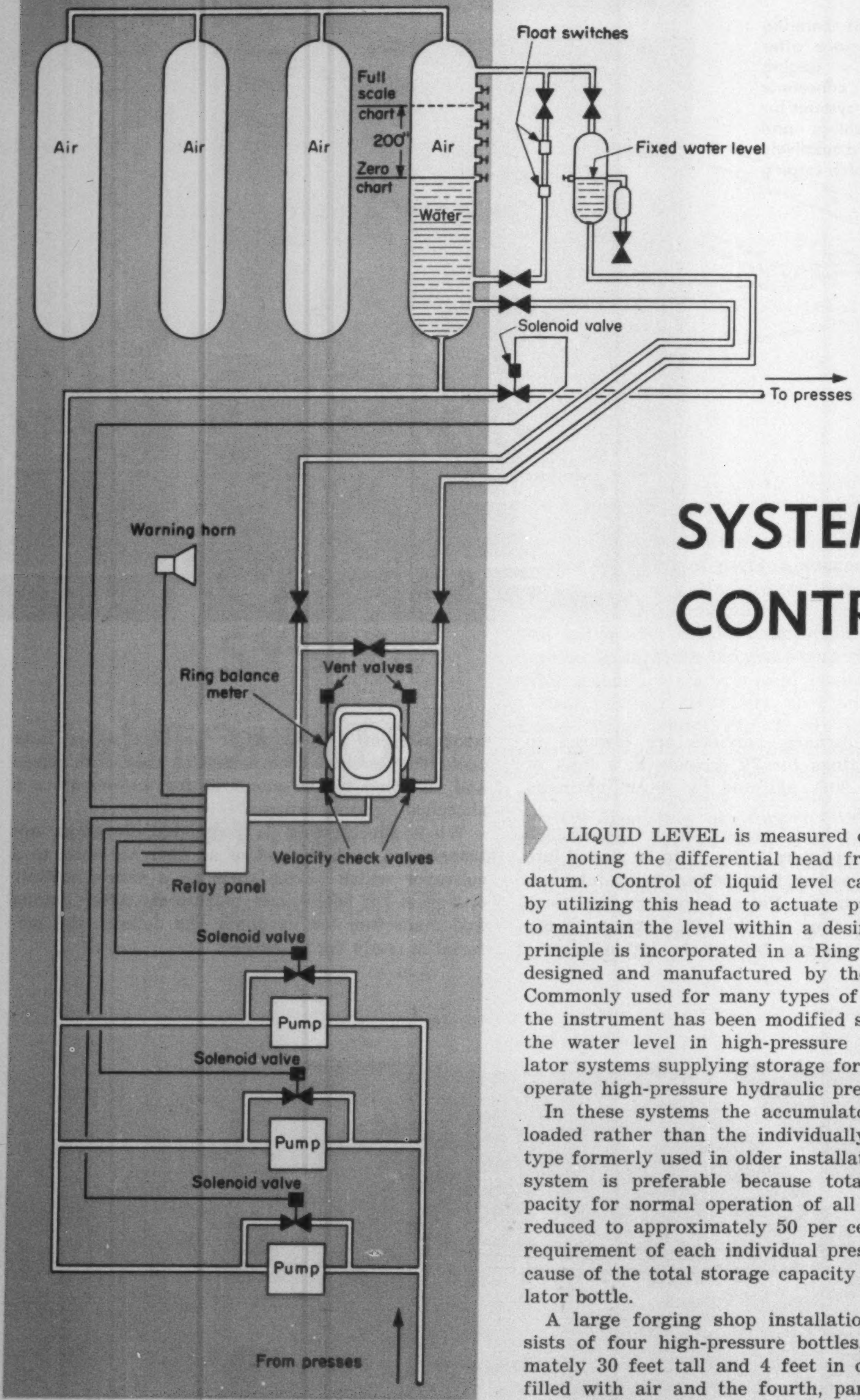

Air
Air
Air
Air
Full scale chart
200"
Zero chart
Water
Float switches
Fixed water level
Solenoid valve
To presses
Warning horn
Ring balance meter
Vent valves
Velocity check valves
Relay panel
Solenoid valve
Pump
Solenoid valve
Pump
Solenoid valve
Pump
From presses

Fig. 1—Installation recently placed in service at a large forge shop to supply hydraulic pressure for presses. With this arrangement, the gage may be located in any remote position

LIQUID LEVEL is measured conveniently by noting the differential head from a reference datum. Control of liquid level can be provided by utilizing this head to actuate pumps or valves to maintain the level within a desired range. This principle is incorporated in a Ring Balance Meter designed and manufactured by the Hagan Corp. Commonly used for many types of flow metering, the instrument has been modified so as to control the water level in high-pressure bottle accumulator systems supplying storage for pumps used to operate high-pressure hydraulic presses.

In these systems the accumulator bottle is air loaded rather than the individually loaded piston type formerly used in older installations. The new system is preferable because total pumping capacity for normal operation of all presses can be reduced to approximately 50 per cent of the total requirement of each individual press—possible because of the total storage capacity of the accumulator bottle.

A large forging shop installation, *Fig.* 1, consists of four high-pressure bottles, each approximately 30 feet tall and 4 feet in diameter—three filled with air and the fourth, part air and part water. Water storage capacity is in parallel with five sets of pumps and is used for storage during low consumption and as an additional supply of high-pressure water during peak loads which would exceed the capacity of the five sets of reciprocating

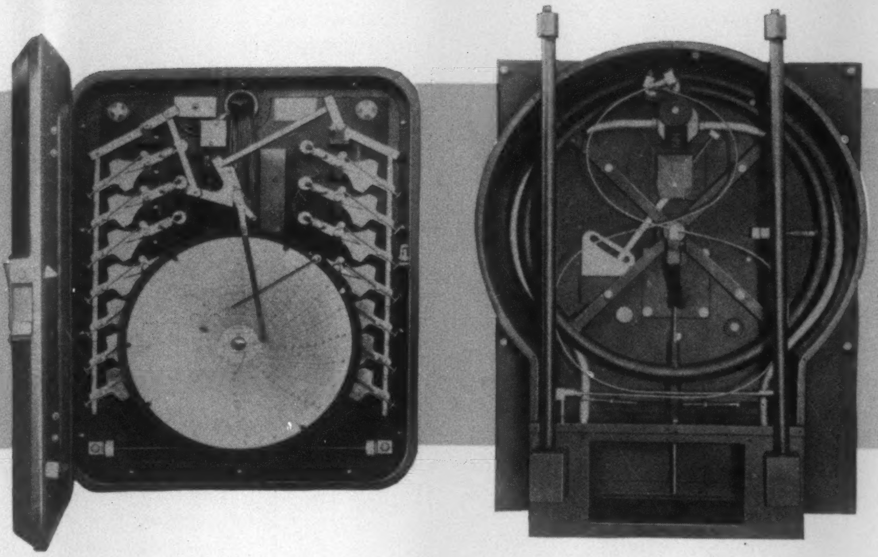


Fig. 2—Front and rear view of the Ring Balance gage showing the 14 mercury switches and the actuating mechanism. Each switch may be adjusted individually and the calibration of the entire assembly shifted by the knurled knobs just below the recording disk

HYDRAULIC SUPPLY
FOR HIGH-PRESSURE PRESSES

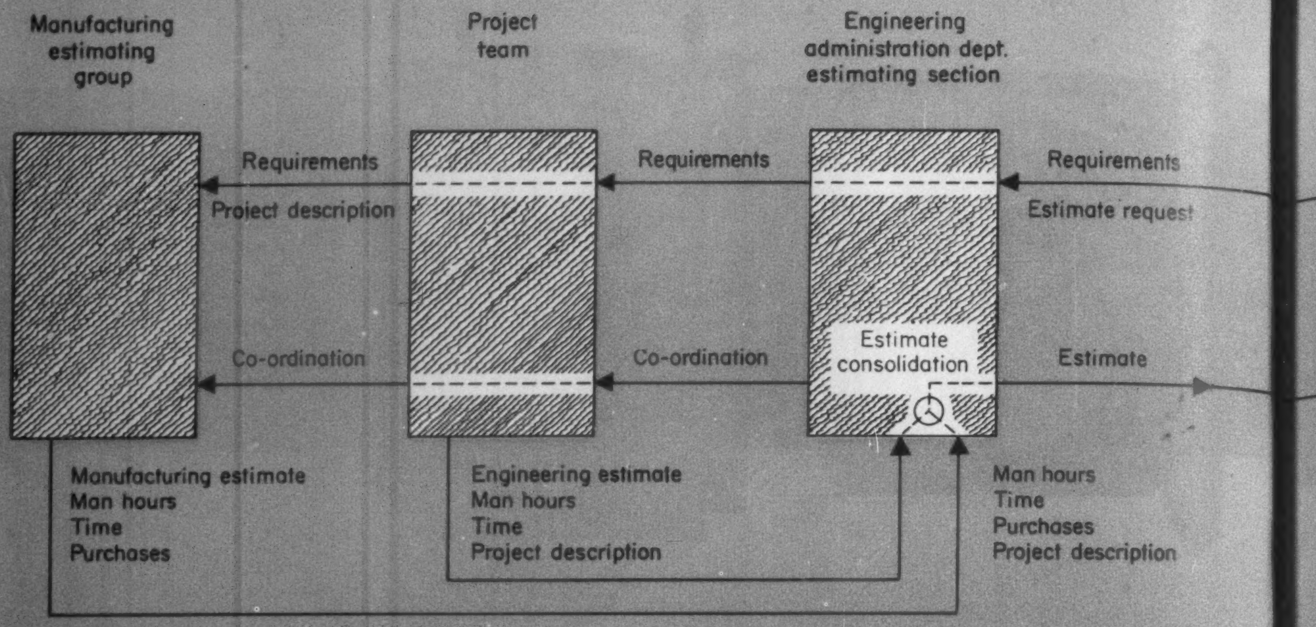
pumps, normally equipped with solenoid valve unloaders for rapid on and off operation.

Pumping may be controlled by either the level of water in the accumulator bottle, or by the air pressure above the water—a change in water level results in either expansion or compression of the air. However, air pressure changes within the bottle are affected by ambient temperatures through the gas law relationship. Disadvantage of the pressure method of control results from an appreciable gain in air temperature as a result of continued compression and expansion during heavy forging operations. As a result, it is not possible to correlate a definite pressure for each water level in the accumulator bottle and therefore it is more dependable to use a direct water level measurement for pump control purposes, since variations in pressure do not appreciably interfere with accuracy of the level measurement.

Water in the first accumulator bottle must be maintained so that no air escapes into the main line because of too low a water level—air in the hydraulic system may cause serious damage to the presses. Also, the water level must not rise enough to create a dangerous high-pressure condition due to compression of the air. Normal operating pressure for this particular system is approximately 2300 psi; exact pressure maintained is not critical, as long as it is less than the designed rating of the system, and greater than the minimum required by the presses. Pressure variations may be as high as 100 or 200 psi in either direction from normal operating pressure.

A special Ring Balance differential gage, *Fig.* 2, records and controls the water level in the accumulator bottle. The water connection from the bottom of the bottle is connected to the high-pressure side of the meter while a static-pressure connection is made to the low-pressure side of the gage. Changes in water level cause rotation of the ring. Extra torque above that normally provided by smaller ring assemblies is required for accurate positioning of 14 mercury switch assemblies which are positioned from the motion of a cam follower through a linkage arrangement. Each switch may be adjusted individually to operate at any desired position within the overall range.

As the water level changes, the meter differential is altered, causing rotation of the ring which closes or opens the switches in sequence. Two switches are used to operate each set of pumps started by a decrease in water bottle level actuating a mercury switch at a predetermined point. Each set of pumps is stopped as the level increases to a second predetermined point, thus requiring two switches per set of pumps to establish the proper control band. Other switches are used as safety devices or to actuate alarm signals. All switches operate through relays with holding circuits as required for actual operation of pumping equipment.


Manufacturing estimating group
Project team
Engineering administration dept. estimating section
Requirements
Project description
Requirements
Requirements
Estimate request
Co-ordination
Co-ordination
Estimate consolidation
Estimate
Manufacturing estimate
Man hours
Time
Purchases
Engineering estimate
Man hours
Time
Project description
Man hours
Time
Purchases
Project description

MANAGEMENT OF SYSTEMS PROJECT

Part 3

By E. D. GITTENS
Chief Engineer, Arma Div.
American Bosch Arma Corp.
Garden City, L.I., N.Y.

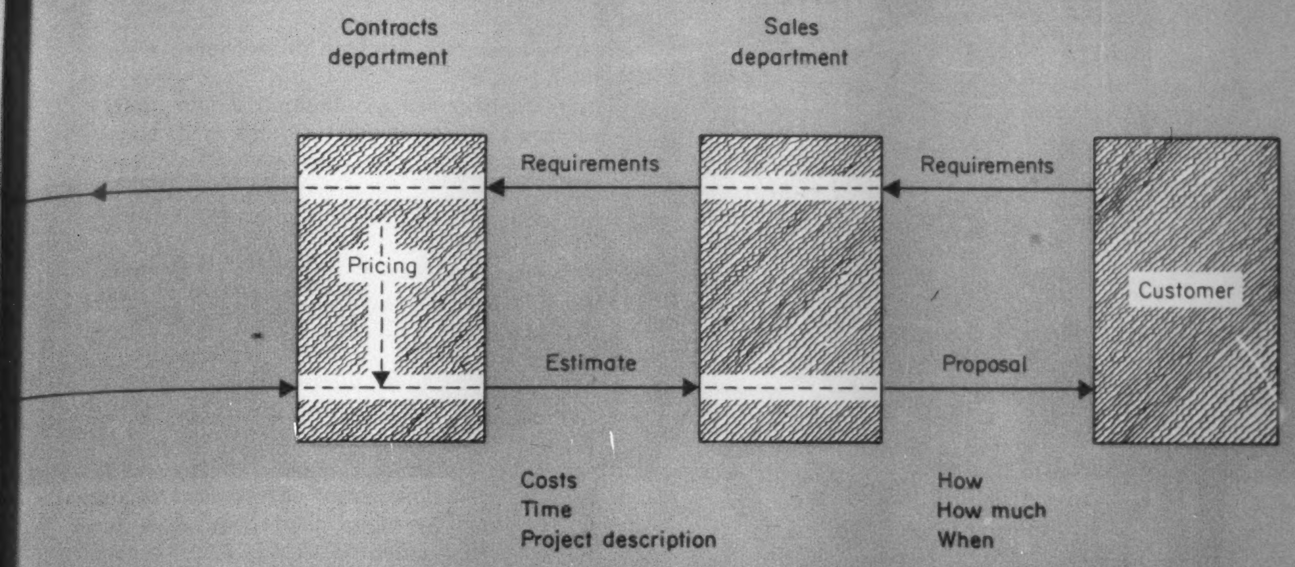
The important questions of How, When, and How Much, for automation programs can be continuously and satisfactorily monitored by a system of controls which measure performance in these areas. By establishing close control and good communication at the project level, a build-up of data becomes available for the successive control and administration of groups, departments, and finally the entire organization

RESPONSIBILITIES, authorities, and method of operation of a *Project Team* were discussed in part two of this series, where it was observed that a well-qualified group of engineers could be depended upon to produce an adequate technical answer to the *How* of a project. The two other vital factors in any successful engineering endeavor—*How Much* and *When*—also require constant attention and evaluation. To this end, a system of administrative tools must be developed which will provide a continuous accurate measurement and control of individual project performance and, in turn, the aggregate performance of the entire engineering organization.

Non-technical Aspects

Any engineering organization dealing with a multiplicity of projects must give careful attention to the effective management of certain basic non-technical aspects which are common to all projects. These break down into three principal areas:

1. Staffing
2. Budgets
3. Schedules



Estimating procedure at Arma Div. of American Bosch Arma Corp.

ENGINEERING MEASUREMENT AND CONTROL

Staffing—A vital commodity in the successful prosecution of any project is appropriate competent manpower. In addition to solutions for the problems of employee selection and training, management must formulate assignments of proper size staffs. Too large a staff or too small a staff each produces difficulties, but in any case the appropriate size must be determined to permit timely progress on the project without waste or inefficiency.

Budgets—Every project has a price tag attached. Whether it be a proprietary enterprise designed for competitive sale of a resultant product, or whether it be a fixed price or cost-plus-fee type of contract, the project must be controlled to attain its objective within a specified budget. A casual attitude on this aspect of a project can be a disastrous luxury.

Schedules—Time is a vital factor in any project. Just as every project has a price tag, it always has a schedule. Price can sometimes be adjusted, but a missed date is irretrievable. A lagging enterprise not only can produce a dissatisfied customer, or failure to meet competition, but it usually throws cost out of balance and, in itself, can create serious financial loss.

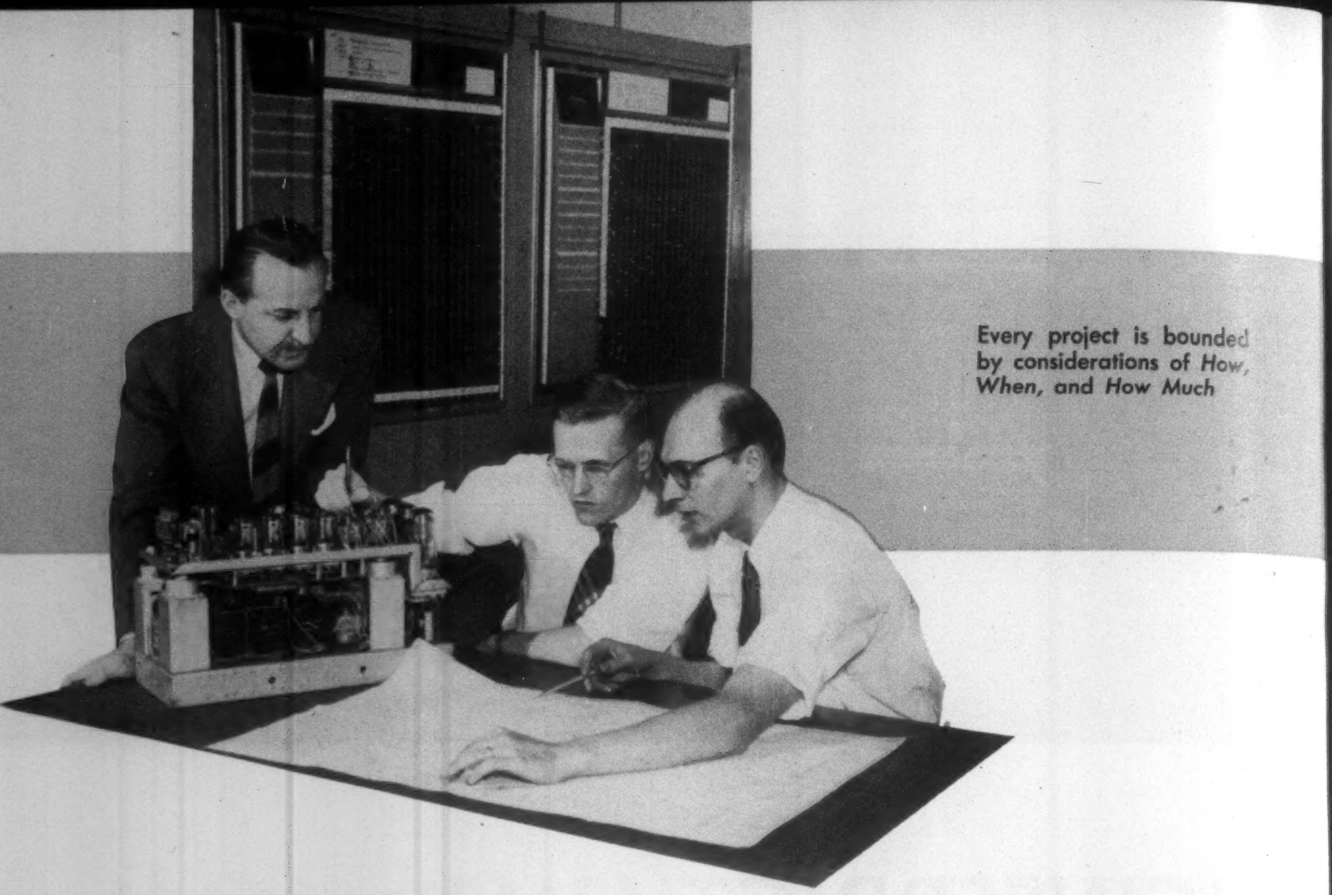
The preceding factors may appear too obvious to require statement, but treated separately for the purposes of administrative control, they permit management to come directly to grips with the *How Much* and *When* of any project.

At Arma, considerable effort has gone into the planning of engineering controls in an attempt to devise a complete set of mechanics for handling all non-technical phases of project operation in a systematic and uniform manner. Further, it was the aim of these mechanics to provide the project co-ordinators with direct aid and support in their "housekeeping" responsibilities with regard to budgets and schedules.

▶ Project Pattern

That a system of administrative controls needs to be tailored to suit the particular requirements of an individual organization is true, but it may be of interest to use the systems at Arma Div. as a case example of one viewpoint and approach to a problem which is common to many organizations engaged in project engineering.

In the engineering division, all project control services and systems are centered in a staff or-



Every project is bounded by considerations of *How*, *When*, and *How Much*

ganization known as the engineering administrative department. This department has an estimating section and a budget control section as well as other service functions. These two sections perform a vital role in the conduct of project control procedures as will be seen in the following discussion.

To understand this system it is well to trace a new job from its very beginning as outlined in the accompanying chart on estimating procedure. The nucleus of a new project is a customer's set of requirements either for a product or for engineering services. These are obtained through customer contacts maintained and developed by the sales department with engineering participation and support as required.

When the customer's requirements have been formalized by the sales department, they are forwarded to the contracts department. The contracts department requests an estimate from the engineering division and from the manufacturing division, forwarding all the customer's specifications, schedules, and drawings to the estimating section of the engineering administration department. The estimating section then acts as co-ordinator of all estimating activities throughout the entire company.

▶ Project Description

Upon consultation between the head of the estimating section and the chief engineer, responsibility for the engineering share in preparing the estimate is delegated to a particular engineering department specializing in the type of project involved. Engineers are then selected to participate in the effort and form a project team for handling the project if an order is obtained. These engineers conduct the necessary study of the job requirements and lay out the basic approach. Upon completion of this job analysis, a *project description* is prepared by the project team in co-operation with an engineer from the estimating section. The representative from the estimating section acts as a consultant and co-ordinator for those portions of the estimate contributed by other sections of the company, such as manufacturing, purchasing, etc. The project description is an extremely important part of the estimate, defining exactly what equipment and services are covered by the estimate. It is often made part of the customer's purchase order and must be prepared with thought and care.

▶ Estimating

The data prepared by the assigned department during the study of the customer's requirements, together with the project description, form the basis for the estimates of all participating activities within the company. Here the estimating engineer from the engineering administration department takes on his active role of co-ordinator and assists the manufacturing estimating group in the preparation of their contributions to the estimate by acting as consultant and interpreter of the customer's requirements and the planned approach to the project.

When all participants in the estimate have developed their figures, each fills in a form showing his estimated man hours and the elapsed time necessary for the performance of his individual function. The estimating engineer then constructs a composite estimate from this data showing time schedules, man-hour budgets, and purchasing requirements, and obtains confirmation from the head of each participating activity by signature on an estimate form.

Thus it is seen that the *How Much* and *When* is obtained in the form of man hours and a timetable for the entire prospective job.

Upon completion of the estimate, the estimating engineer reviews the total result with top management, and, upon their approval, forwards the estimate to the contracts department for pricing. The final estimate with costs, time schedules, and project description is then forwarded to the sales department and in turn, to the customer.

▶ Control of Project

Assuming that the foregoing procedure results in an order, it will be noted that the preceding process has established the foundation for subsequent operations. A project team has been tentatively formed; all participants in the job have set the boundaries of their activity in the form of man hours and material costs, which now become their budgets; and time schedules have been established in detail for the entire project.

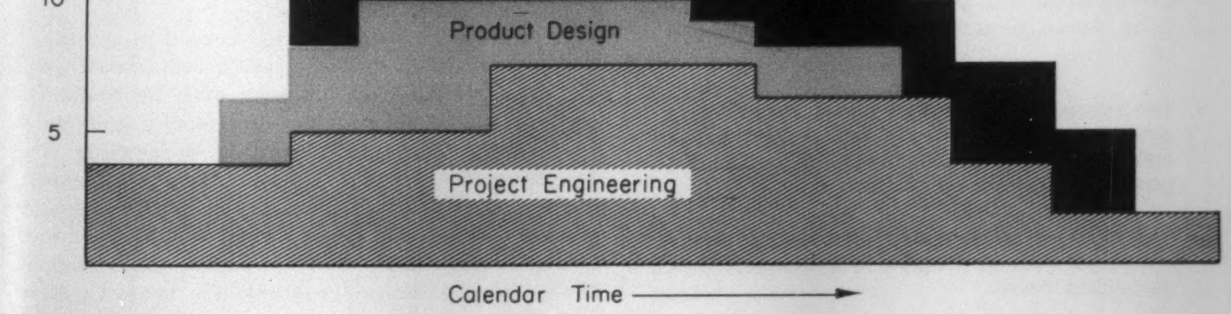
At this point the *How Much* and *When* are clearly a contractual obligation and the next problem is the control of all activities to continuously monitor their performance within these established limits. Obviously, the successful completion of any project within budgets and schedules rests on the accuracy of the original estimates of cost and time; and accuracy can only be arrived at through experience and careful crosschecking of past performance in similar situations. However, assuming competence in estimating, the monitoring of budgets and schedules can be accomplished by continuous systematic attention.

At Arma the focal point of all project administration and control is the project team. This group of engineers is responsible for the success of the project through technical accomplishment within the framework of established budgets and time schedules.

▶ Manpower Schedules

The first action at the outset of a new project is to assign the necessary engineering manpower and a *project co-ordinator* to launch and follow through on the endeavor. Detailed requirements are established to accomplish the expenditure of the estimated man hours within the schedules of the contract. These plans are worked out in the form of charts of men versus time such as the accompanying composite manpower schedule for each phase of the engineering activity. If the project involves a manufactured product, the manufacturing manpower requirements are handled in a similar manner by the production planning section of the manufacturing division.

These charts are submitted to the supervisors of the various departments involved in the project, who approve the planned requirements and then assume the responsibility of providing the



Composite manpower schedules furnish supervisors with the means for planning staffing requirements project with the necessary manpower support.

It is interesting to note that through the medium of such project manpower charts for each project the individual supervisor is readily furnished the means for planning his total departmental staffing requirements.

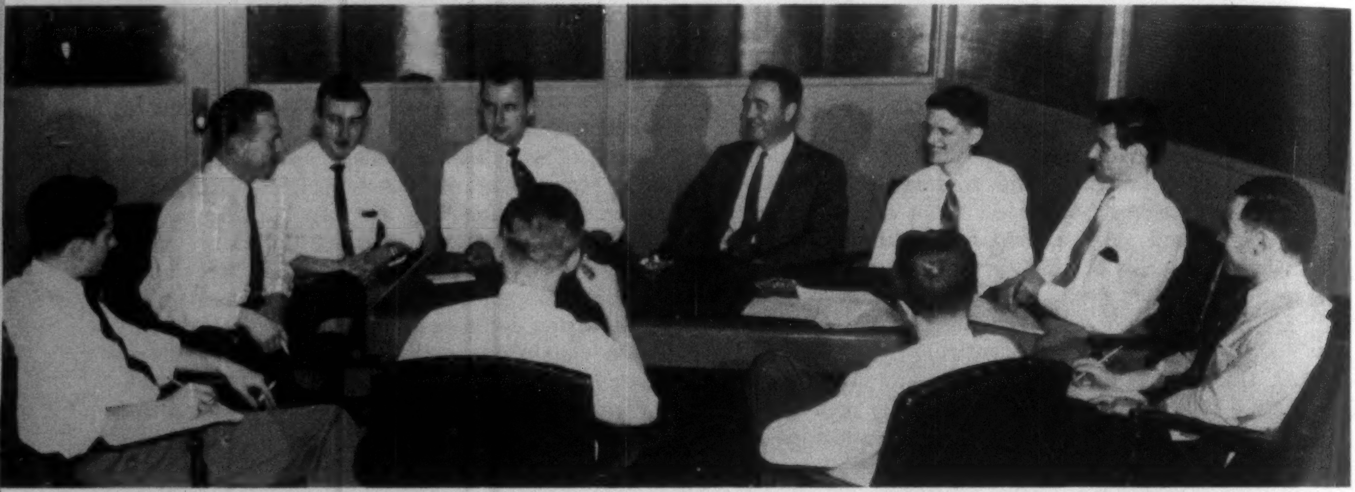
Project Status Reports

The policing of the expenditure of manpower and money is accomplished through the medium of *project status reports* which are prepared and published monthly by the project co-ordinator who has the administrative responsibility for the project. Each report outlines the current project status and includes in the opening paragraph a summary of the overall progress of the project. Among other points the report covers:

1. The status of engineering manpower expenditures expressed in terms of unexpended budget hours versus total hours required to complete the project.
2. The status of total project money expenditures determined by comparing the percentage of budgeted funds expended with the estimated percentage of work completion.
3. The status of project schedules determined by comparing the job progress with the scheduled completion dates.

This information is determined by the project co-ordinator through personal observation and assessment and by the use of data supplied to him as a control service by the budget control group in the engineering administration department. This acts as a service organization to the project co-ordinator by providing periodic reports prepared from company records of manpower expenditures, dollar expenditures, percentages of completion, delivery performance, etc. Thus the mechanics of record keeping are confined to a special group which acts to support the project co-ordinator in his assessment of the progress of the project.

The most important aspect of the project status report is that if properly used it provides a means of predicting trouble in time to make remedial action effective. These reports are forwarded each month to the appropriate supervisors, the chief engineer, and the budget control group. The chances for defections to go unnoticed in the progress and administration of a project are minimized, since the project co-ordinator must review and report on the health of the project monthly. Management is kept in close and continuous touch with project status, and the budget control group acts as an ever-alert policeman over all project performances with regard to costs and schedules.



A project description is prepared by the project team in co-operation with an engineer from the estimating section

It is indeed meaningless to succeed in control of expenditures and time if a project is unsuccessful technically. Justification may even be found for failure to live within time and money budgets if the resultant accomplishment is worthwhile. The technical progress is the most difficult to measure since it does not lend itself to accounting mechanics but rather must be judged by personnel of sufficient background and experience to recognize satisfactory technical progress of a project. Man-

The mechanics of record keeping are confined to a special group which acts to support the project co-ordinator in his assessment of the progress of the project

agement must therefore be technically equipped to perform this important role.

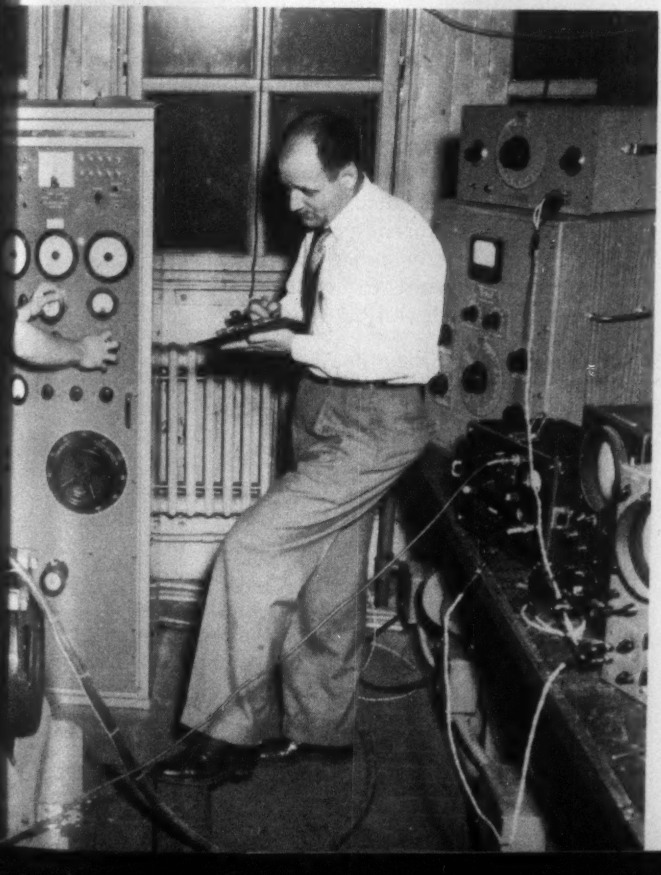
A very necessary factor in the assessment of technical accomplishment is continuous communication with the project. Nothing can take the place of a competent and experienced management in close and constant contact with the work. This can be augmented by staff meetings and also through periodic reports and special reports by the project engineers to describe the progress of the work, statements of new problems, the disposition of old problems, and the program for the future. The project status reports include such information in accordance with established procedure for report writing.

Another much broader yardstick for measuring technical accomplishment is obtained through the comprehensive comparison of the position of one's own organization with others in its field. Is the project forging a position in the forefront of competition? Are new advances being made in the art through invention or novel combinations and applications of ideas? Is the quality of the work such as to put the company's products and services in demand by customers?

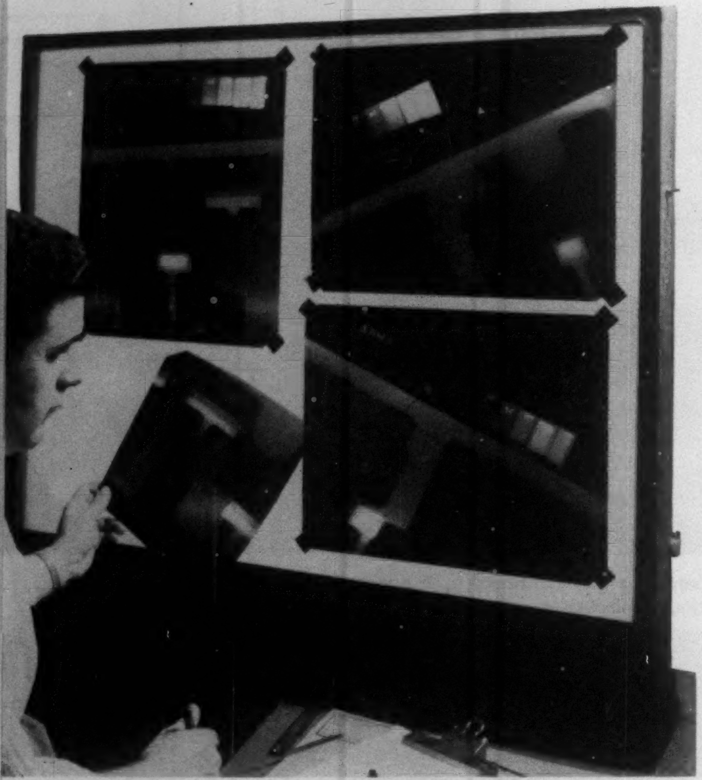
These yardsticks, however, are only aids to final judgment and the burden of evaluating technical accomplishment must finally be borne by those in a position to oversee the project.

▶ Control of Entire Organization

It may be seen from the foregoing discussion that through the medium of project controls, data is available continuously on the requirements and



A very necessary factor in the assessment of technical accomplishment is continuous communication with the project



An important broad yardstick for measuring technical accomplishment considers whether the quality of the work is such as to put the company's products and services in demand by customers

condition of *Manpower, Finances,* and *Schedules* for the engineering effort on each and every project. It becomes a simple matter from that point to assess the total situation for the entire engineering organization.

It was noted that each engineering department or group was provided through project control procedures with data to judge their individual staffing requirements. These individual requirements may then be reviewed and approved by higher management levels for the purpose of broad planning and action. The consolidation of the individual manpower requirements provides a base for planning of facilities, recruiting programs, training programs, and the like, for the entire organization.

Again through the medium of project controls, the financial status and health of each engineering activity is continuously monitored, and by consolidation of all such data the financial condition of the entire engineering organization is reflected. This provides a picture of general financial health, permits forecasting capacity for new business, and provides data for studies of operating costs, overhead ratios, etc.

Complete and unified control of schedule performance is provided by combining all schedule data into one master schedule for the entire organization. This permits policing of overall performance and provides easy reference for planning and co-ordination of all company activities.

As mentioned earlier, the administrative controls on the overall engineering organization are vested in an engineering administration department which is a staff organization of top engineering management. This group is continuously engaged in the processes of estimating, budget controls, and analyses of manpower, schedules, and finances. It may be of interest to observe that this staff organization also aids in facility planning, and the recruitment of technical personnel, plans and operates training programs, a technical library, and typing services.

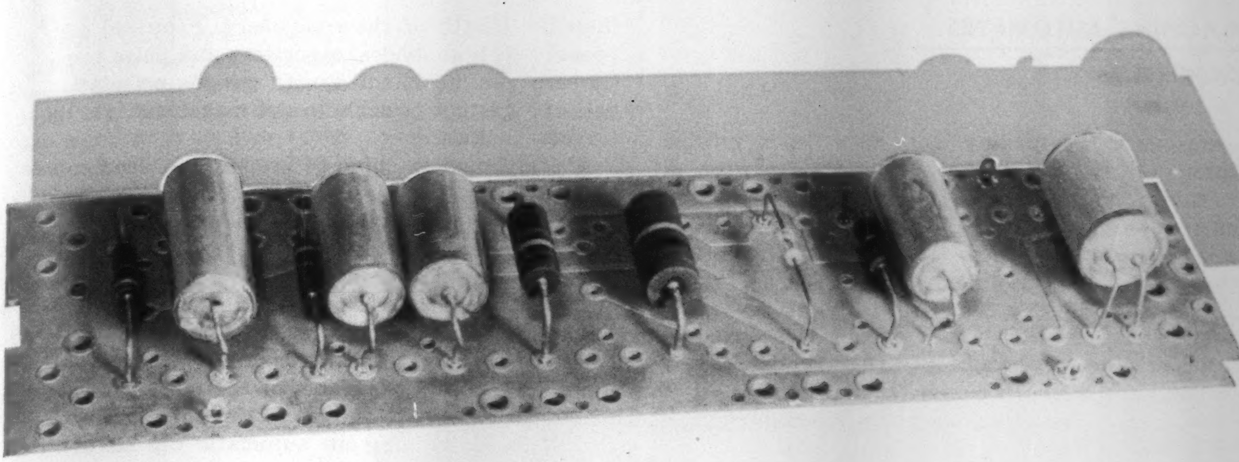
In summary, it has been shown that the important questions of *How, When,* and *How Much* for engineering programs can be continuously and satisfactorily monitored by a system of controls which measure performance in these areas. These measurements depend to a degree upon human judgment, but much can be done to reduce them to a set of mechanics.

By establishing close control and good communication at the project level, a build-up of data becomes available for the successive control and administration of groups, departments, and finally the entire organization. Such a system becomes particularly important and necessary as the number of projects simultaneously active in a company increases.

The study and attention given to the control of time and money on any project should compare substantially with that given to a project's technical aspects. Each is a major ingredient in overall success.

THE AUTHOR

EDMUND D. GITTENS has been associated with many pioneering developments of electromechanical devices and computers now in use by the armed services. A graduate of Massachusetts Institute of Technology with Bachelor of Science degree in 1935, he joined Arma where he is now chief engineer and general administrator of the Engineering Division involved in research, design and development of complex systems engineering related to such items as bomber defense, inertial navigation, gyro devices, navigation equipment and a variety of computers for Ordnance applications. He is a member of ASME, SAE, and recipient of Naval Certificate of Merit.



MACHINE AUTOMATES ASSEMBLY

OF PRINTED ELECTRONIC CIRCUITS

AUTOMATIC ASSEMBLY has been given increased development emphasis recently in order to maintain the rapid pace with advances in other automation areas. These efforts have produced steady improvement, particularly in electronic component assembly. Printed circuits provided the initial impetus and now rapid strides are being made in automatically inserting electrical and electronic components into these circuits.

The first commercially available automatic assembly machine for attaching diverse components to printed circuits has been developed and sold by the Mechanical Div. of General Mills Inc. to International Business Machines Corp. The machine, called "Autofab", *Fig.* 1, will be used by IBM in production of printed circuit subassemblies for large air-defense computers being built for the Air Force and requiring thousands of these building-block circuits. Preliminary production studies indicated that the only way to meet delivery dates was through automation.

Principal parts of the Autofab machine are a feeding mechanism for the printed circuit baseplates, *Fig.* 2, 24-attaching heads complete with controls and components feeders, a conveyor system for moving baseplates along the assembly line, a positioning mechanism for locating baseplates under the attaching heads, and interlocks to insure proper sequencing. Only as many heads as are required are used for circuits carrying less than 24 components. The system is not tailored to a single circuit—IBM plans to use the machine for several hundred different assemblies.

In operation, the printed circuit feeder is loaded with 400 baseplates and each of the 24 heads is filled to capacity (average of 600 pieces each) with components. All the attaching heads, controlled by a cam shaft, operate simultaneously. As each printed circuit plate reaches a position under an attaching head, *Fig.* 3, the conveyor system stops momentarily, the head attaches its component and the conveyor resumes its progress. When the plate reaches the next head, the operation is repeated until all 24 components have been attached, *Fig.* 4.

Loss of operating time is reduced by use of multiple magazines on the baseplate feeder and the attaching heads. Magazines are turned automatically so that when one is emptied of components, a full chamber immediately moves into operating position. Empty magazines can be filled while the machine is running.

Automatic stoppage of the machine occurs upon improper or incomplete attachment of any one of the components—a head may have exhausted its component supply and not have been refilled through oversight on the part of the operator. A warning light flashes on that particular operating unit; no time is lost in locating the trouble. Because the machine is stopped, no material is lost through defective assembly.

The machine can be adjusted to accommodate printed circuit plates of varying lengths and widths; either dimension is variable from 2 to 10 inches, and minor design changes permit use of other sizes. The attaching heads are interchangeable, can be located in any station position in the line and weigh only 25 pounds.

No shock loads or abrupt changes in velocity are imposed on the circuit cards or components. All attaching forces are applied directly to the component leads so that damage to components during assembly is decreased. The methods of shaping leads can be used on a wide range of components without major adjustments. Several modes of attaching components to the circuit cards are possible—flat on the board, with a stand-off from the board, or mounted in holes spaced closer together than the length of the component. Polarized components such as diodes, capacitors and pulse transformers can be handled with proper orientation, because it is not possible to put magazines into the turrets backward.

A companion machine to prepare and load components is under construction. All but polarized components are simply poured from the package into a hopper. The preparation machine straightens and trims leads, puts on wrap-around sleeves and loads components into the magazines that are later hung on the attaching head turrets.

After completing the cycle, the fully assembled unit is fed onto a conveyor for the next operation, either inspection or automatic dip soldering. General Mills is building an automatic dip soldering machine designed by IBM as another companion to the basic assembly machine.

Results are the standard products of automation—increased output at lower cost with improved quality. Estimated capacity is better than 200,000 assemblies per month based on a 40-hour week for this single machine. Although originally designed for use in computer applications, *Fig.* 5, utilization in commercial mass production of radio and television sets certainly can be assumed to be in the near future.

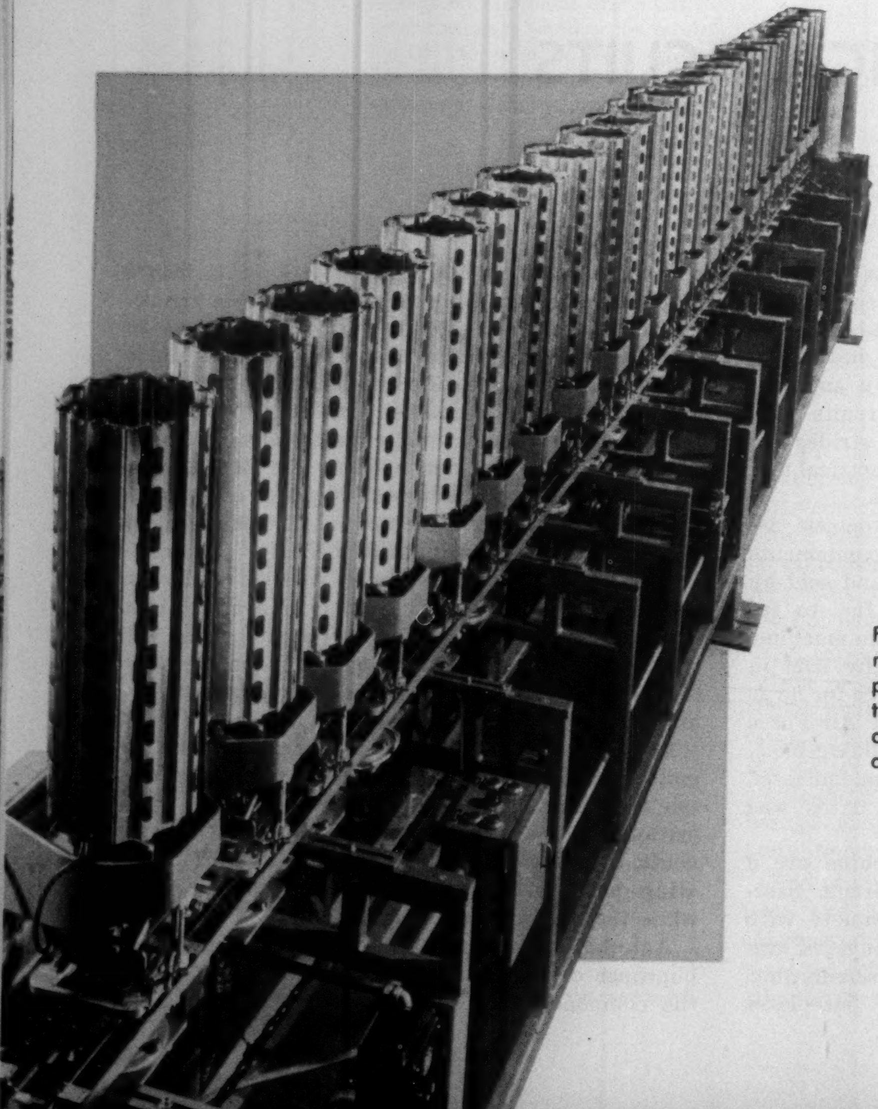
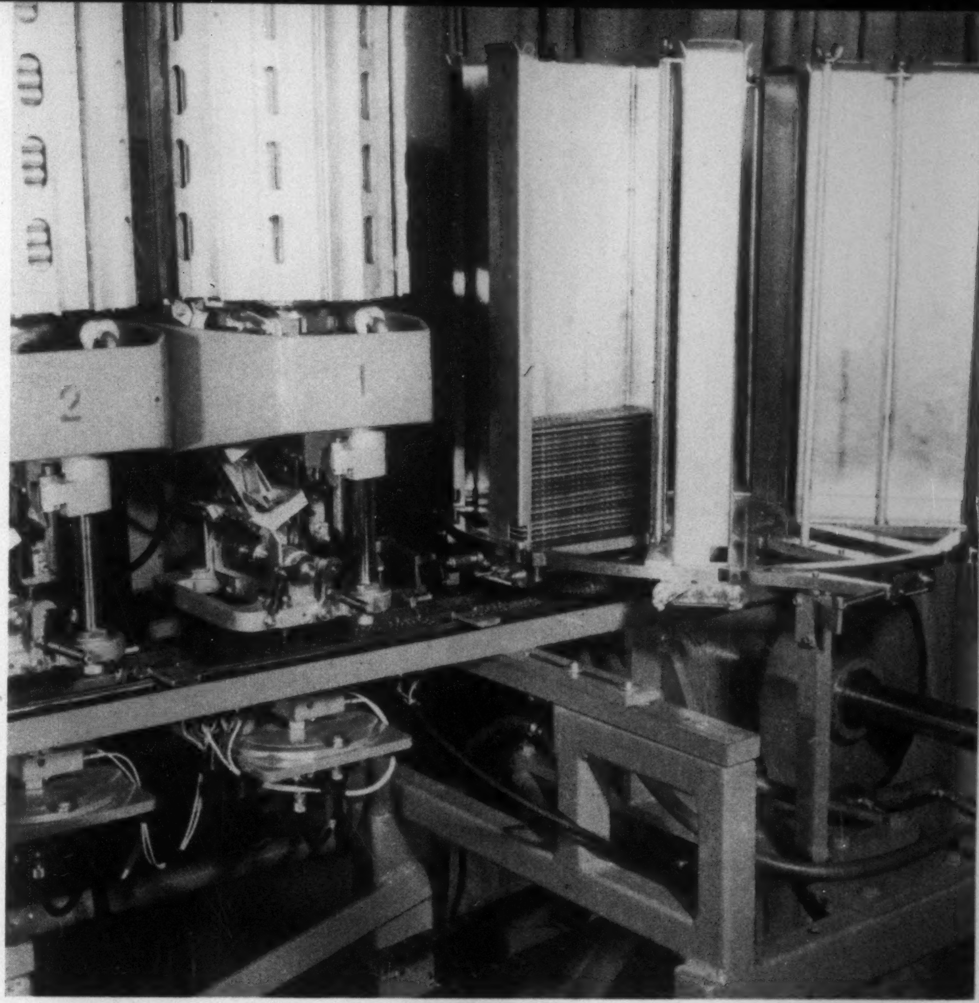
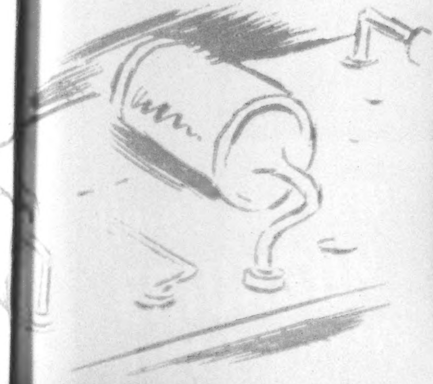


Fig. 1—This automatic electronic assembly machine inserts from 1 to 24 electronic components—assorted resistors, capacitors, pulse transformers and diodes—into printed circuit boards. Normal speed is 20 assemblies a minute, nearly 10,000 in an 8-hour day

Fig. 2—At the beginning of the automatic assembly line, printed circuit cards feed onto the conveyor from the turret at the right. As they move down the line each stops in turn under each of 24 attaching heads (first and second shown) to receive assorted components. The circuit card turret and component turrets all rotate automatically as a magazine or container empties, bringing full ones into operation. Empties are refilled while the machine remains in operation





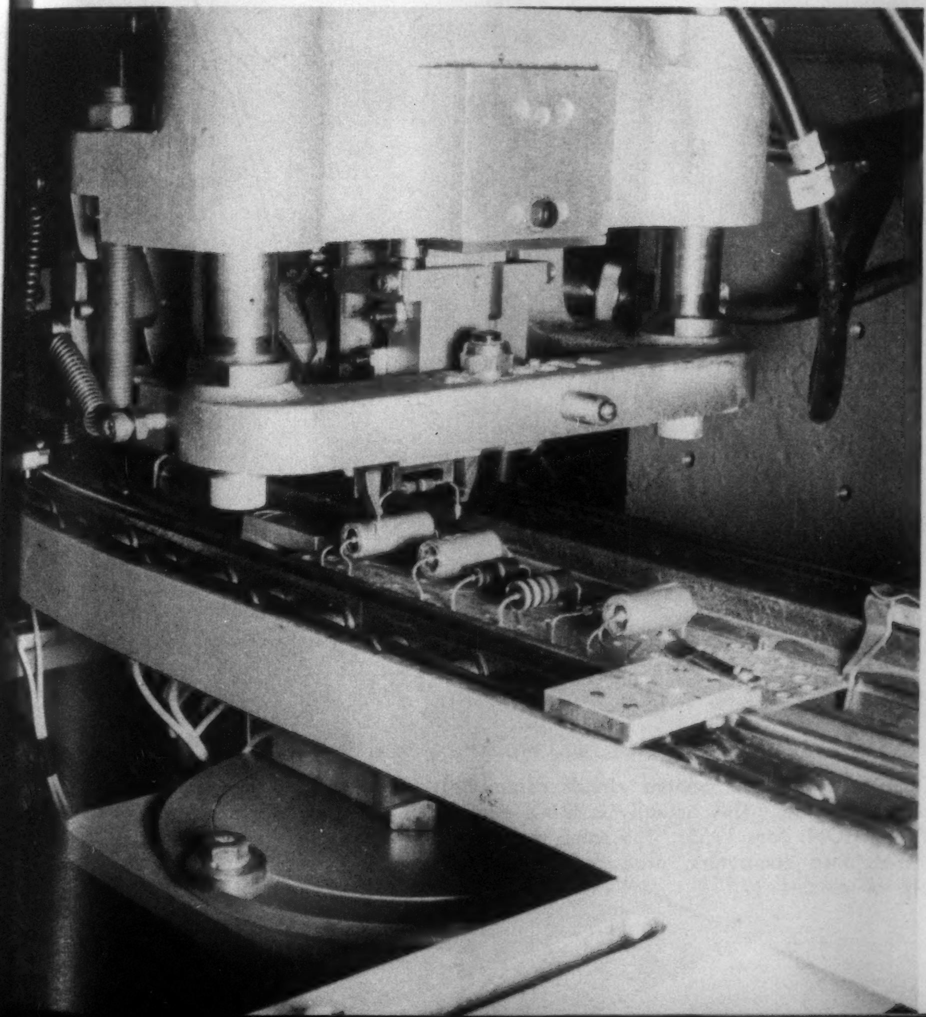


Fig. 3—Action of the machine during insertion of a small resistor. A partially assembled, plastic, printed circuit card is shown about to receive the resistor, whose leads are already bent to the proper spacing. The wrap-around sleeves on the leads which give an off-the-board mounting are a development by IBM. The machine inserts a wide variety of electronic components in addition to resistors

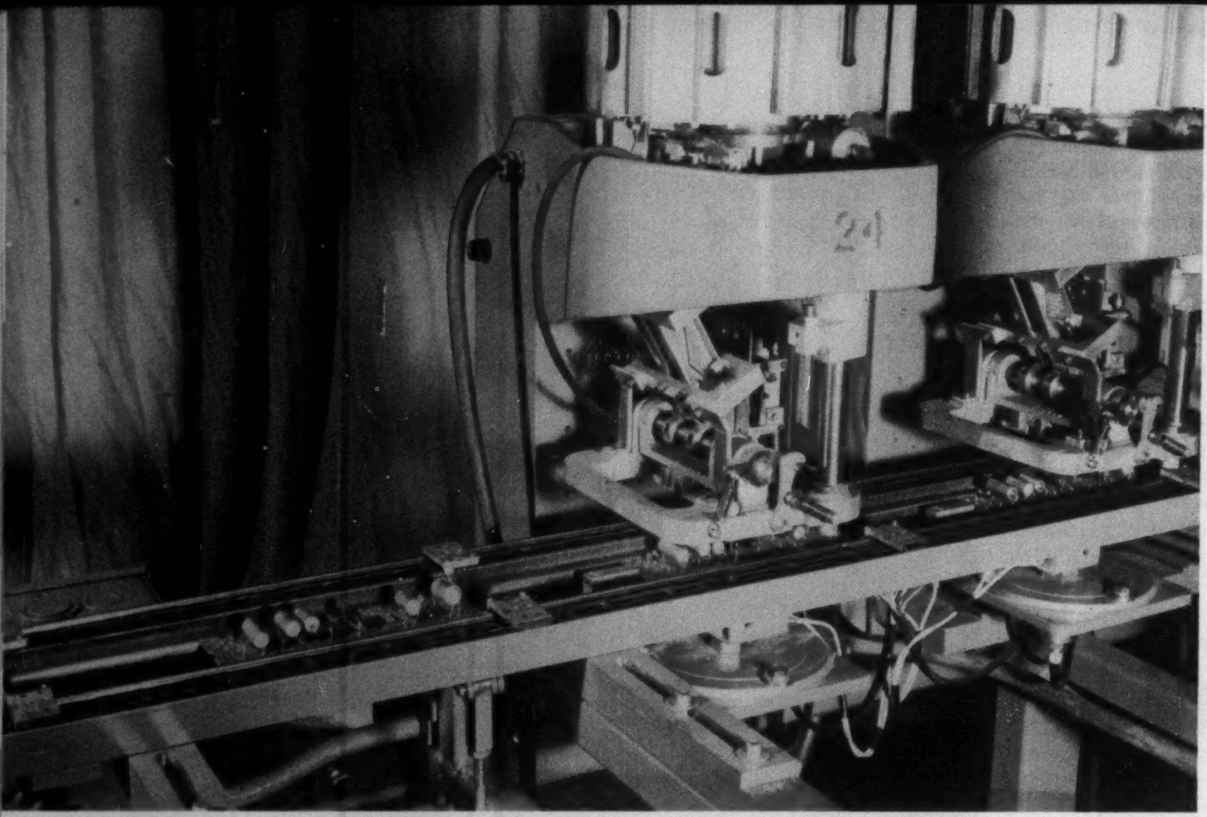


Fig. 4—Completed assemblies at the end of the line. In this case the automatic electronic assembly machine has inserted 11 assorted components. Minor redesign would enable the machine to handle more than 24 components

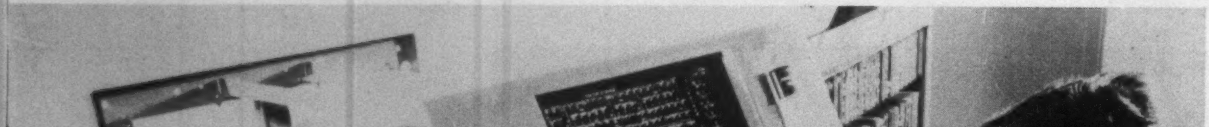
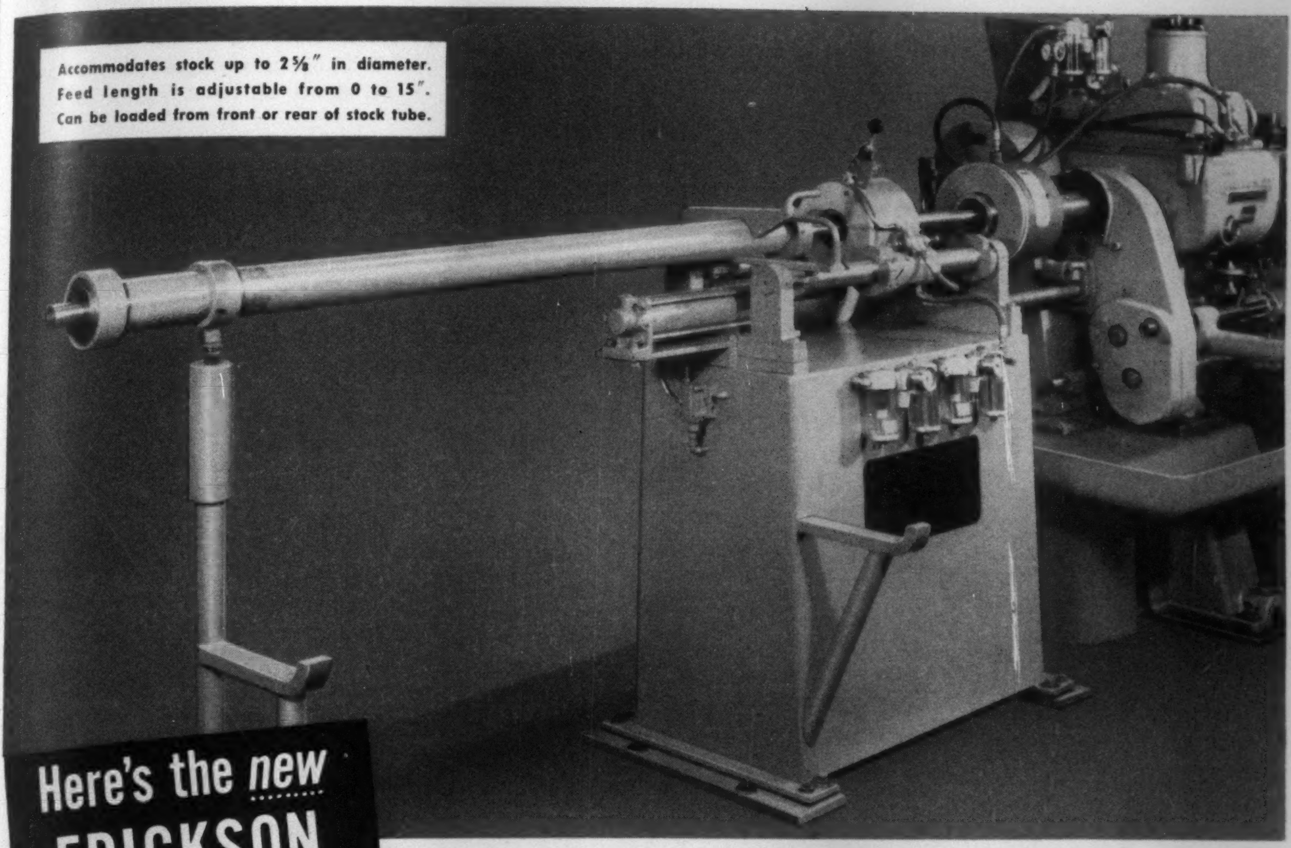


Fig. 5—Type of computer construction that will use printed circuit assemblies from the automatic electronic assembly machine. This actually is IBM's experimental transistor computer (see AUTOMATION, Jan. 1955). The same techniques will be used in putting together air-defense computers, produced faster and cheaper through automatic assembly of circuits



Accommodates stock up to 2⅝" in diameter.
Feed length is adjustable from 0 to 15".
Can be loaded from front or rear of stock tube.

Here's the *new* ERICKSON PNEUMATIC BAR FEED!

...An Automatic Air Stock Feed and Collet Operating Unit Designed to Operate with any Collet Equipment

- *Increases production*
- *Reduces operator fatigue*

THIS NEW ERICKSON Stock Feed automatically feeds bar, hex or tubing stock to your machine tools for rotating or non-rotating machining operations. It is an air-powered, fully automatic unit which is quiet, simple to operate, safe to use, rugged and dependable. It can be used with any type of collet equipment.

EASE OF OPERATION reduces operator fatigue and speeds set-up cycle time. One valve controls entire operation. At a flick of the valve handle, spindle collet opens and feed chuck advances stock to preset length; feed chuck then opens its jaws. Another flick closes spindle collet on stock and returns feed chuck to its starting position where it closes its jaws on stock to give double grip.

AA-976

OPERATIONAL ADVANTAGES

- Assures positive movement of stock. No dragback of stock on return stroke.
- Adjustable feed chuck jaw pressure eliminates marring or crushing of stock while providing positive grip.
- Permits use of exact size, polished stock.
- Provides double grip on stock to resist "pushback".
- Stock feed is adjustable to suit cycle time and bar size.
- Stock moves with spindle rotating to reduce cycle time.
- No safety controls needed due to basic design.
- Filler tube is supported over its length by ball bearings in stock tube. It rotates with stock to prevent marring, eliminate chatter.
- Rugged welded base construction rigidly supports feed chuck, dampens vibration, reduces whip, guaranteeing smoother finishes, quiet operation.

For complete information on the new Erickson Pneumatic Bar Feed, send for your copy of Circular K-2 today!

Erickson
Bar Feed

ERICKSON Holding Tools
Guaranteed Accuracy

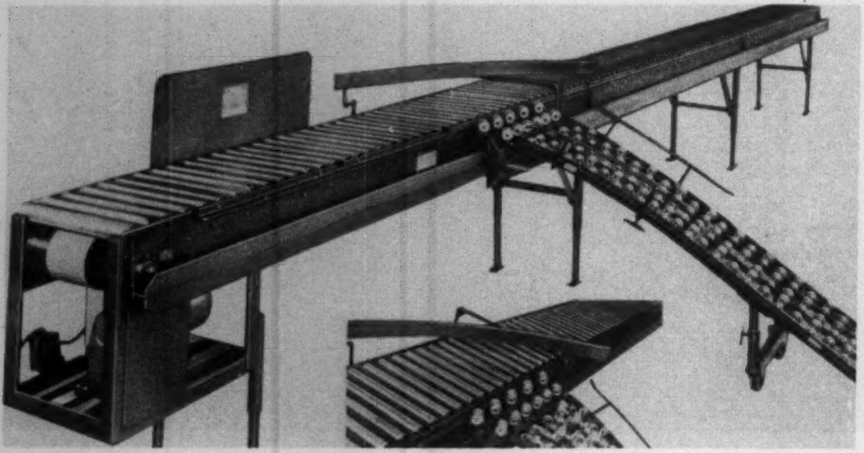
ERICKSON TOOL COMPANY

2307-4 Hamilton Avenue • Cleveland 14, Ohio

COLLET CHUCKS • FLOATING HOLDERS • TAP CHUCKS • TAP HOLDERS • AIR-OPERATED CHUCKS
EXPANDING MANDRELS • SPECIAL HOLDING FIXTURES

AUTOMATION new equipment

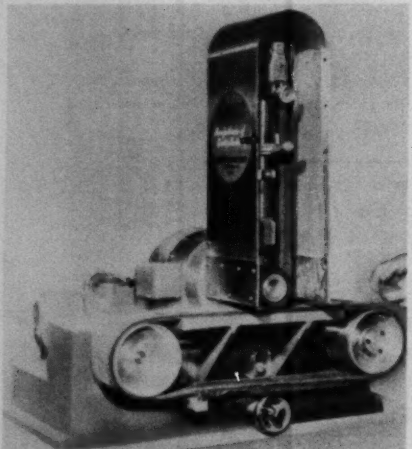
Machines and plant equipment designed for more automatic operation



MOVABLE SPUR AND DIVERTING RAIL

Originally designed for high speed delivery of packaged newspapers to three truck loading stations, new unit can be used in wholesale and warehousing operations and for feeding production work to assembly, inspection and packaging lines in industrial applications. Movable spur and diverting rail, called "Trav-A-Spur", is built as a single unit which travels the length of the company live roller conveyor. Unit is equipped with ball bearings throughout and has its discharge end mounted on caster wheels that run on the floor. Trav-A-Spur is available in height adjustments to match the live roller conveyor which it serves in widths of 11½, 15, 18, and 24 inches. **Metzgar Conveyor Co.,** 408 Douglas St. N.W., Grand Rapids 4, Mich.

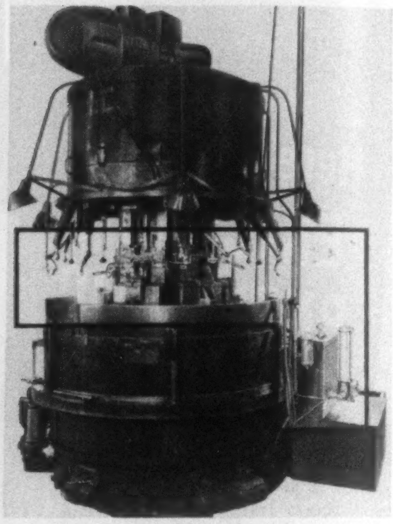
Circle No. 1 on Reply Card



GRINDING MACHINE

All purpose grinding, polishing and deburring machine handles many types of material and provides production possibilities at low equipment cost. Drive motor for conveyor belt of this bench type abrasive-belt machine is variable speed, has 3 to 1 ratio, ⅓-hp motor. Drive motor for the spring tensioned coated abrasive belt is 1½-hp, with 3600 rpm. Belt can be changed and tracked in a few seconds. Hand wheel adjusts the grinding head for variations in stock thicknesses and regulates grind pressure. Multiple grinding heads for rough to finish grinding operations can be provided. **Curtis Machine Corp.,** Jamestown, N. Y.

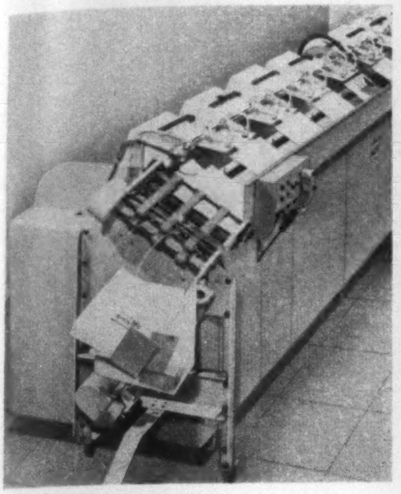
Circle No. 2 on Reply Card

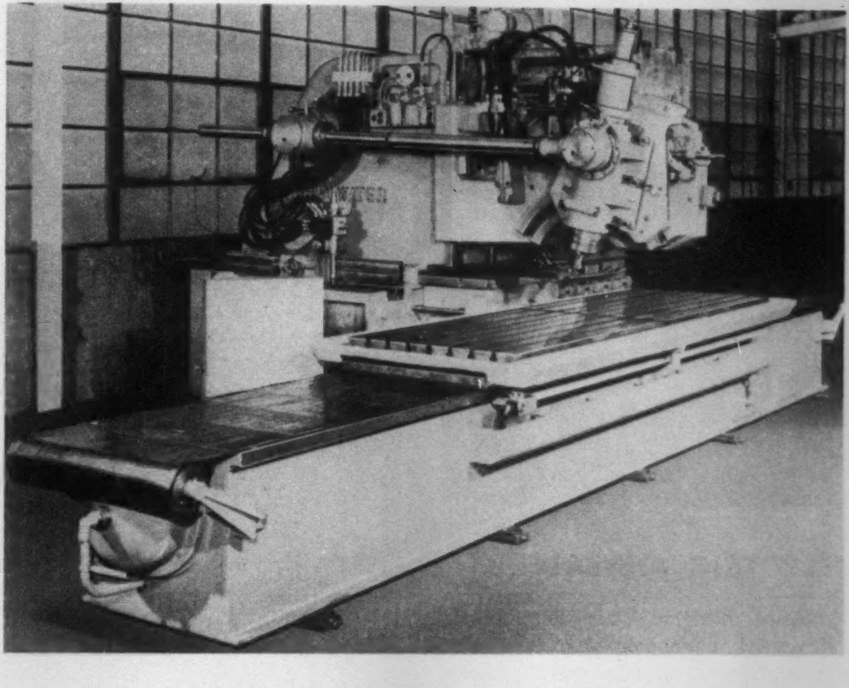


LUBRICATION SYSTEM

Automatic application of fluid lubricants to bearings on individual industrial machines at predetermined intervals is provided by air-operated centralized lubrication system. System is designed for servicing machines operating at varying rates of speed where applications of lubricant at varying intervals may be required or for lubrication of automated machine lines. Three types of control are available; mechanical—using motion of machine to actuate an air valve which in turn cycles lubrication system; electrical—using an adjustable time clock to actuate a solenoid air valve which cycles lubrication system at intervals of 7½-minutes to 3 hr; manual—using an air valve actuated by machine operator. System uses an automatic safety control. **Industrial Div., Lincoln Engineering Co., 5794 Natural Bridge Ave., St. Louis 20, Mo.**

Circle No. 3 on Reply Card





CONTOUR MILLING MACHINES

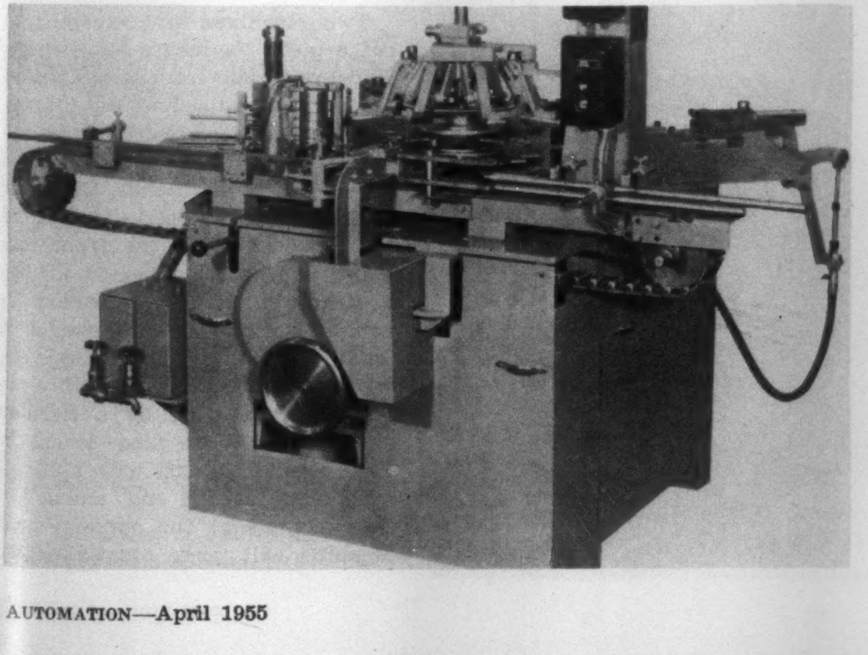
Designed for machining complex aircraft structural components, new contour milling machines are said to reduce time and cost of milling profiles requiring gradually changing angles of the machined surfaces. Tracing motions of the machines are hydraulically controlled through use of a tape cam made of Mylar, a very stable plastic material. Fabricated into an endless belt, this cam, having the template form of the piece to be milled, guides the stylus which actuates the hydraulic trace valves. Method eliminates need for a separate template table. Machine itself cuts template form into cam belts. Cutter and model are coordinated through use of a master perforation on the tape which engages a master tooth on the geared rollers driving the belt. Geared drive spindles with change-gear boxes provide speeds from 100 to 3000 rpm. Interchangeable motorized spindles furnish horsepower and speed ranges as needed for contour milling of both steels and nonferrous metals. **Bridgewater Machine Tool Co.,** Akron, O.

Circle No. 5 on Reply Card

COLLATOR

Eight-station machine can gather up to 32,000 sheets of paper per hour in sets of eight. Collator will handle materials ranging from 3 x 5 inch card stock to 12 x 17 inch paper. Among accessories available are offsetting delivery units, tape conveyors and stitching attachments. Uses of machine include collating of price sheets, bulletins, catalogs and instruction manuals. **Macey Co.,** 5350 W. 130th St., Cleveland 30, O.

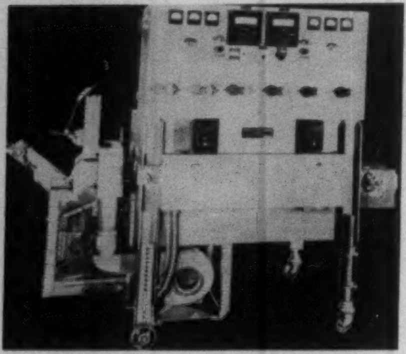
Circle No. 4 on Reply Card



LABELING MACHINE

Designed to meet production requirements of the food, drug, cosmetic, paint, and liquor industries, automatic labeling machine is called the "Pony Express". Machine can produce approximately 4000 labeled pieces per hour and features ability to change over quickly to a new container and label. Suction is used to pull the label out of the hopper, carry it over the glue roll and deliver it to the container. Suction mouthpiece is mounted on a rotary indexing head, and glue handling system employs vertical glue roll, a circulating pump and a glue reservoir large enough to permit glue settling. **New Jersey Machine Corp.,** 16th St. & Willow Ave., Hoboken, N. J.

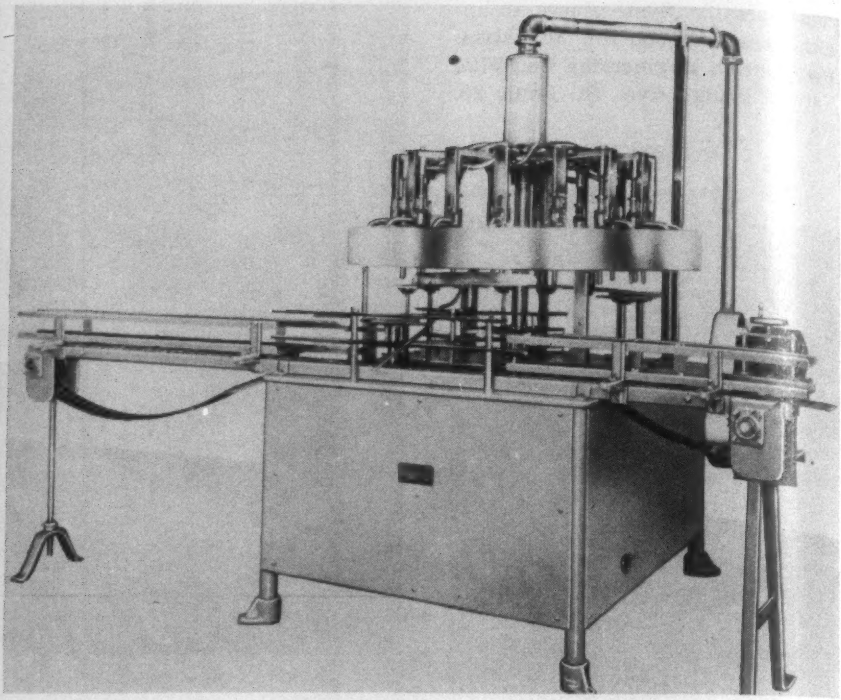
Circle No. **6** *on Reply Card*



ELECTRIC ANNEALER

Small electric glass annealer is designed to work with machine fabricating subminiature parts, and will operate at temperatures up to 1100F. Machine requires maximum of 15 kw for heating, has a 6-inch wire mesh belt, 3-inch tunnel height, and 4-ft, 3-inch tunnel length. Annealer has low pressure blower at exit end to cool annealed glass parts to handling temperature. Safety features include high and low temperature visual and audible signals, with an excess temperature fuse as an additional safeguard. Larger model designed for annealing of component parts for power and other large electronic tubes is also available. **Forter-Teichmann Co.,** Pittsburgh, Pa.

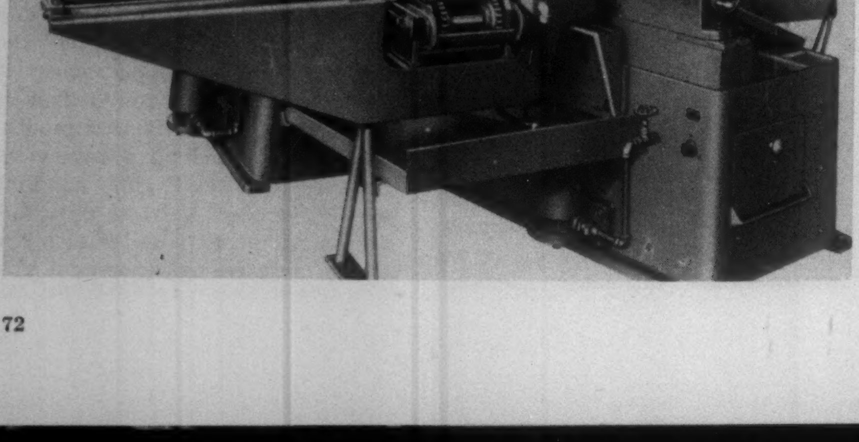
Circle No. **7** *on Reply Card*



AUTOMATIC ROTARY BOTTOM FILLER

Designed for foamless filling of liquids such as floor waxes, detergents, and shampoos, multi-spout, automatic rotary filler is available with up to 30 spouts. Machine will fill metal or glass containers from 8 oz to 1 gal. Containers are fed to the filling stations by a conveyor, where a star wheel moves them to platforms which carry them under the filling nozzles. The platforms lift the containers up under the nozzles, which enter the containers and are forced against the container bottoms. This causes the sleeve valves of the nozzles to open, filling the containers from the bottom up. Nozzle and platform rotate until container is filled. Excess flow of liquid is guided into an overflow trough, and is then recirculated to the main tank. Liquid may be fed to the machine by pump or gravity. The 16-spout model (above) fills at a rate of 30 or 40 one gallon containers a minute. **MRM Co., Inc.,** 191 Berry St., Brooklyn 11, N. Y.

Circle No. **8** *on Reply Card*

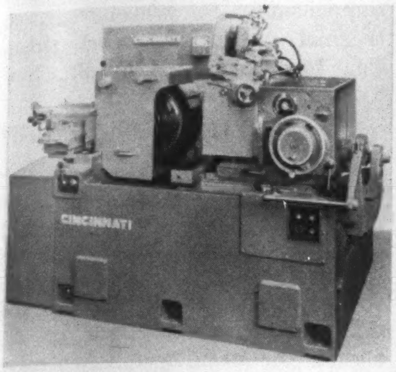


SAWING MACHINES

Two machines are combined to cut a piece $2\frac{5}{8}$-inches long with a 90-degree angle from stock, with a 15-degree angular cut on the opposite end. Rear machine cuts a piece twice the finished length to provide the square ends. Conveyor indexes the cut piece to the second loading station on the front machine which is positioned at the 15-degree angle. Front machine is equipped with angular jaws on a double acting, self-equalizing vise, which hold the double length piece during the cutting by a circular saw blade. When piece is cut in half, result is a part with a 15-degree angle at one end, and a 90-degree angle at the opposite end. Machine will make approximately

89 cuts per hour. **Motch & Merryweather Machinery Co.,** 888 E. 70th St., Cleveland 3, O.

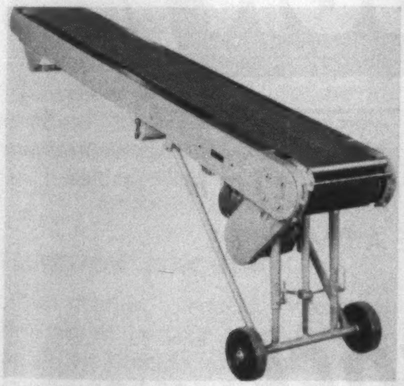
Circle No. **9** *on Reply Card*



GRINDING MACHINE

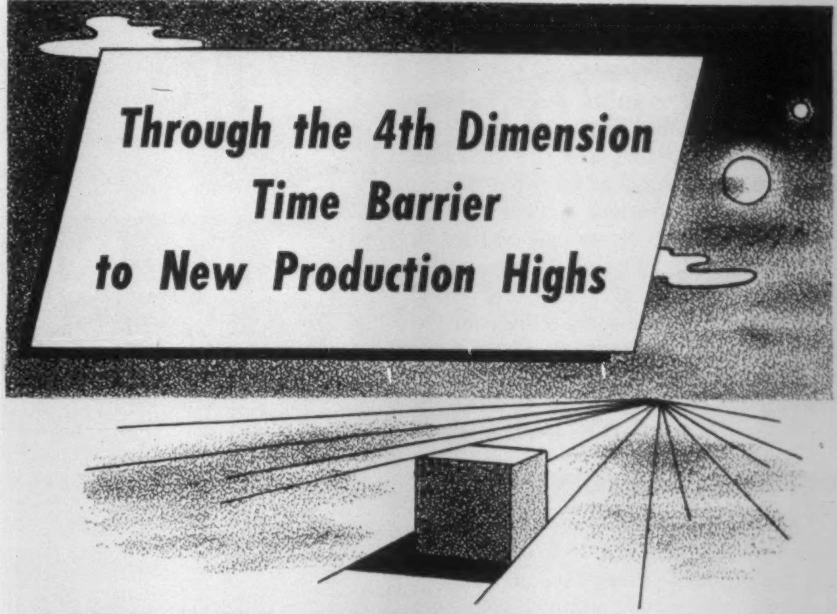
Centerless grinding machine which is 1000 lb heavier than previous model of this type offers wide range of applications through variety of standard fixtures and attachments. Machine has self-adjusting, automatically lubricated Filmatic bearings for grinding wheel spindle. Among attachments available are automatic infeed attachment, single, double and quadruple pitch infeed screws, pushbutton compensating sizing equipment, precision infeed slide indicator, bracket which converts standard workrest to roller infeed workrest, feedmatic hoppers, automatic grinding wheel balancing mechanism and wrap around fixture which raises workpiece from between wheels. **Cincinnati Milling Machine Co.,** Cincinnati 9, O.

Circle No. **10** *on Reply Card*



PORTABLE CONVEYOR

Standard line of utility belt conveyors has been adapted to portable



Through the 4th Dimension Time Barrier to New Production Highs

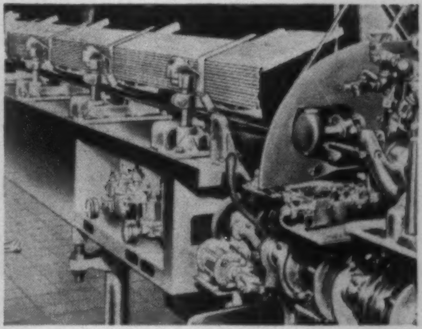
LIPE AML BAR FEED

gears machine production to the steady flow of Time

ALL industrial results are achieved in Time . . . *vital 4th dimension that measures output, costs, profit.* Shorten the time gap between operations . . . shorten the time when machines are "cutting air" . . . keep machines producing at a steady optimum rate during the fatigue slow-down from 10:30 to noon, and from 3 P.M., till closing time . . . *and you are getting 4th Dimension production.* Production that is geared to the steady flow of Time.

Lipe AML Bar Feed Produces from 30% to 100% More Output by Eliminating Time Losses . . .

Time losses account for the enormous differences in output among workmen. By eliminating these losses automatically, the Lipe AML Bar Feed boosts overall production from 30% to 100%. That's because stock is fed to the machine independent of the operator. Constant pressure behind the stock assures uniform speed of feed. No feed fingers to fail or mar stock. No multiple feed-outs, even on the longest pieces.



Mail the coupon now for free literature giving full details on the Lipe AML Bar Feed.

LIPE ROLLWAY CORPORATION
Syracuse 4, N. Y.

Sure, I'd like to know more about the Lipe AML Bar Feed. Send me your free booklet.

Name__________ Title__________
Company__________
Street__________
P.O.__________ Zone_____ State__________

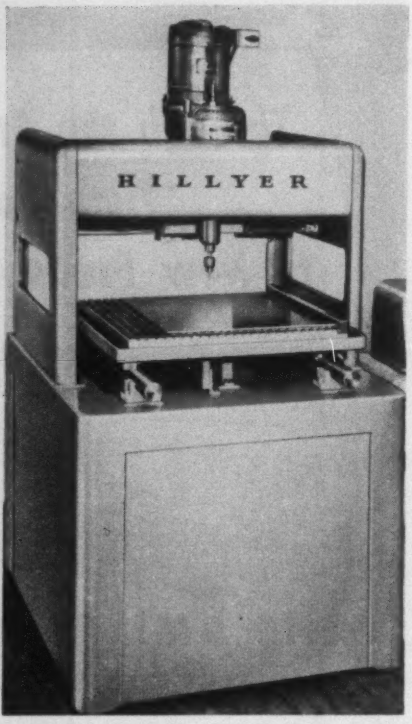
LIPE ROLLWAY

use. Designed for use in elevating or lowering boxes, cartons, sacks or other commodities from dock to truck or from floor to stack, conveyors are available with adjustable wheel support on the drive end and a pad support on the other end. Standardized lengths are 5½, 8, 10, 13, and 15 ft, in belt widths of 10, 14, 16, 20, and 24 inches. Units are made of steel, but on lightweight applications, subassemblies can be fabricated of high strength aluminum. **Standard Conveyor Co.,** North St. Paul 9, Minn.

Circle No. **11** *on Reply Card*

DRILLING MACHINE

Designed to automatically locate and drill any number of holes up to ½-inch diameter, drilling machine eliminates manual layout of templates, panels, chassis, printed circuits and castings. Machine is equipped with an adjustable speed drilling unit (275 to 4250 rpm) which drills to the desired depth. Operator sets length and width dimensions in increments of 0.001-inch on decimal dials and presses direction controls to set the machine in motion for locating process. When the selected position is located, the drill head is automatically actuated. **Hillyer Instrument Co., Inc.,** Dept. 27, New York 13, N. Y.



Circle No. **12** *on Reply Card*

GRINDING CONTROL

to a concentricity within 0.00008-inch on work from 3/10 to 4 inches in diameter is provided in cylindrical grinding operations with compensation for wheel wear and thermal expansion. **Kurt Orban Co., Inc.,** 205 E. 42nd St., New York 17, N. Y.

Circle No. **13** *on Reply Card*

RECORDING AMPLIFIERS

one of which accepts signals from resistive and inductive transducers and dual channel amplifiers the other accepts single-ended and differential signals. Both are designed for oscillograph recording applications. **Equipment Dept. RT-4, Brush Electronics Co.,** 3405 Perkins Ave., Cleveland 14, O.

Circle No. **14** *on Reply Card*

INTER-COM SYSTEM

between operators of vehicles such as light haulage trucks, fork lifts, etc. and a central dispatcher is provided for use in the materials handling field. **Femco, Inc.,** Irwin, Pa.

Circle No. **15** *on Reply Card*

FOR MOST MODERN EFFICIENCY IN
CLEANING AND FINISHING METAL PARTS ITS

RANSOMATION

COMPLETE SYSTEM AUTOMATION
IN ANY COMBINATION OF TREATMENTS

OUR REPRESENTATIVES AND
FIELD ENGINEERS ARE
AT YOUR SERVICE TO HELP
REDUCE YOUR FINISHING
TIME, LABOR AND COSTS

RANSOHOFF, INC.

650 NORTH FIFTH STREET—HAMILTON, OHIO

STRAIN GAGE PLOTTER

is designed to obtain multistrain gage data in tests on aircraft, machinery, engine load testing, and other large structures. **Gilmore Industries,** 5713 Euclid Ave., Cleveland 3, O.

Circle No. **16** *on Reply Card*

VOLTAGE REGULATOR

of magnetic amplifier type designed for exciter control applications, can be used with diesel or gasoline engines, induction, synchronous or dc motors, steam or gas turbines to control 5 to 150 kw generators. **Regulator Equipment Corp.,** 56 California Ave., Paterson, N. J.

Circle No. **17** *on Reply Card*

RECIRCULATING OVENS

with automatic straight line temperature control operates oven at minimum wattage input, and eliminates overshooting and undershooting encountered when a fixed wattage is cycled on and off. **Blue M Electric Co.,** 306-08 W. 69th St., Chicago 21, Ill.

Circle No. **18** *on Reply Card*

HYDROGEN ION CONTROL

system for pH recording and control includes an electric dynamaster potentiometer recorder or controller, electrode assemblies in either flow or immersion types, a variety of final control elements for addition of gaseous, liquid, solid or slurried reagents, and a Beckman model W amplifier. **Bristol Co.,** Waterbury 20, Conn.

Circle No. **19** *on Reply Card*

MILK CARTON LOADER

is designed to load gable top half gallon fiber milk cartons at speed of 50 cartons per minute. **Standard-Knapp Div., Emhart Mfg. Co.,** Portland, Conn.

Circle No. **20** *on Reply Card*

TRUNNION MACHINE

four-station, vertical type uses high speed cutting tools to automatically process automobile rear axle housings, including rough and finish facing, drilling, countersinking and boring. **Snyder Tool & Engineering Co.,** 3400 E. Lafayette, Detroit 7, Mich.

Circle No. **21** *on Reply Card*

NEW!

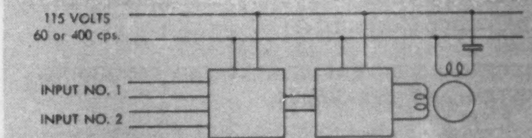
MINIATURE

SERVO

Magnetic Amplifiers

MAGNETIC AMPLIFIERS
632 TINTON AVENUE
NEW YORK 55, N.Y.
MAGNETIC AMPLIFIER
MODEL NO
SERIAL NO

Three New AC Servo Types Available..



STANDARDIZED SERVO SYSTEMS AND OTHER STANDARD TYPES FOR AUTOMATIC CONTROL —

In addition to new lines illustrated, many standard and higher power magnetic amplifiers are available for applications involving automatic control.

CUSTOM DESIGNS FOR SPECIAL REQUIREMENTS

— we design and engineer complete servo or automatic control systems

- **MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS**
  Supply: 115 volt 400 cps.
  Power output: 3.5, 6, 10, 18 watts
  Sensitivity: 1 volt AC
  Response Time: .03 sec.
  Lowest Cost — Smallest Size
  For further information request Form S493
- **MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER**
  Supply: 115 volt 400 cps.
  Power output: 5, 10, 15, 20 watts
  Sensitivity: .1 volt AC
  Response Time: .008 to .1 sec.
  Highest performance — All magnetic
  For further information request Form S496
- **TRANSI-MAG*: TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER**
  Supply: 115 volt 400 or 60 cps.
  Power output: 2, 5, 10, 15, 20 watts
  Sensitivity: .08 volt AC into 10,000 ohms
  Response Time: .01 sec.
  Fast response at high gain
  For further information request Form S499 (400 cps.); Form S497 (60 cps.)

*TRADE NAME

AFFILIATE OF THE GENERAL CERAMICS CORPORATION

MAGNETIC AMPLIFIERS INC. MA

MAGNETIC AMPLIFIERS • INC
Telephone: CYpress 2-6610
632 TINTON AVE., NEW YORK 55, N. Y.

AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

Components

PERIODIC SWITCH FOR USE IN AN ELECTRIC CIRCUIT TO INDICATE THE ROTATION OF A SHAFT

Cam operates to open and close contact as shaft rotates relative to housing. Patent 2,677,021 by Willis A. Baumgardner.

◆ ◆ ◆

Controls

ELECTRONIC DENIER CONTROL

Resistance network, amplifier circuit, speed control means and a pair of tachometer generators connected in series opposition are arranged to adjust the speed of one driven shaft relative to the speed of a second independently driven shaft. Patent 2,676,495 by John S. Seney, assigned to E. I. du Pont de Nemours & Co.

ELECTRONIC SIGNAL CONTROLLED RECORDING SYSTEM AND APPARATUS

Stream of electrically charged marking media is conducted through a precipitating zone and an electric field in a narrow duct to a record receiving medium. Patent 2,676,868 by Carlyle W. Jacob.

SEQUENCE CONTROL CIRCUIT

A combination of networks each comprising an oscillator and a switch controlled by that oscillator. The switch in each network controls an oscillator of one of the other networks. Patent 2,677,762 by Martin J. Cohen, George P. Wachtell, George F. Pieper, Jr., assigned to United States of America.

◆ ◆ ◆

Data Processing

TELETYPEWRITER MESSAGE IDENTIFICATION SYSTEM

Auxiliary numbering transmitters, one for each of a plurality of receiving stations on a channel of transmission, are selectively energized to send a designation code and a letters combination character which energizes a second such transmitter. Patent 2,677,011 by Gordon E. Burwell, assigned to American Telephone & Telegraph Co.

AUTOMATIC PROCESS LOGGING SYSTEM

Logging system repeatedly scans a large number of variables, data being automatically recorded by electric typewriter. Unit indexes logging sheet up and down to record data on each variable in its own area of the sheet. Patent 2,701,748 by Ralph A. Anderson, assigned to Panellit Inc.

PROCESS OF AND APPARATUS FOR DEVELOPING VISIBLE SOUND RECORDS SYNCHRONIZED WITH INVISIBLE RECORDINGS ON MAGNETIC TAPES

Recorded sound on magnetic tape to be edited is recorded as a visible signal indication along tape in synchronism with the invisible sound record. Patent 2,677,728 by Otto K. Kolb and Axel C. G. Petersen, assigned to British Acoustic Films Ltd.

◆ ◆ ◆

Handling

APPARATUS FOR CONVEYING FABRICS AND THE LIKE

Strip of flexible material is transported under uniform tension. Material passes around yielding periphery and around idler shaft with guide bars directing material axially along shafts. Patent 2,701,717 by Frank B. Morrill, assigned to James Hunter Machine Co.

CASE INVERTER

Action of a driven roller and a conveyor belt inverts cases traveling on conveyor by rotating them 180 degrees about a horizontal axis which is perpendicular to the line of travel of the cases. Patent 2,677,452 by Robert J. Mallow and Fred W. Stradtman, assigned to Pressed Steel Car Co. Inc.

BELT CONVEYOR

Short auxiliary endless conveyor supports load bearing run of an endless material conveyor at points where heavy materials are dumped onto material conveyor. Spring loaded supports at one end of auxiliary conveyor absorb vertical momentum of material. Patent 2,677,456 by Keith McCann, assigned to Goodman Mfg. Co.

◆ ◆ ◆

Machine Tools

CONTROL DEVICE FOR AUTOMATIC MACHINERY

Device senses position of tool on automatic machine tool and renders turret inoperative if tip of tool is not in normal position. Designed for use on turret type machine with several tool positions, this control automatically adjusts to predetermined proper positions for the various tools being used. Patent 2,677,168 by Leon Dewan.

WORK-LOCATING STOP MECHANISM FOR AUTOMATIC LATHES

Work stop is consecutively moved into and out of its operative position respectively before and after a feed movement, or is restrained out of operative position for an adjustable number of feeds. Patent 2,676,385 by William E. R. Pulman, assigned to C. V. A. Jigs, Moulds and Tools Ltd., England.

◆ ◆ ◆

Machines

ASSEMBLING MACHINE

A machine for assembling commutators by placing a core-sleeve, insulating washers, and clamping collars upon an annulus of metal bars and insulating separators in a holding ring. Patent 2,676,394 by Richard M. Goodwin, assigned to General Motors Corp.

◆ ◆ ◆

Measuring

THICKNESS MEASURING APPARATUS FOR SHEET MATERIAL

Angular movement of a roll mounted on a pivot above a conveyor is a measure of the thickness of the sheet material moving thereon. Circuit includes detector for energizing indicator and timer to limit distance along which thickness determination takes place. Patent 2,676,412 by Roger L. Griffith, assigned to Swift & Co.

◆ ◆ ◆

Packaging

WRAPPING MACHINE

Articles in succession are lifted into the path of a wrapper which is severed from the leading edge of a web. Linkage tests for presence of article in the recess of the feed disk. Patent 2,676,441 by Leonard Brook, assigned to Forgrove Machinery Co. Ltd., England.

BAG FILLING AND CLOSING MACHINE

Machine forms bags successively from a web of heat sealable material, discharges bags bottom end first on endless belt conveyor with fixed uniform spacing between bags. Bags move on second conveyor to filling station. Patent 2,676,442 by Rene J. Gaubert, assigned to Simplex Packaging Machinery Inc.

◆ ◆ ◆

Process Design

METHODS OF COATING SHEET MATERIAL WITH PARTICULATE MATERIAL

Process applies continuous uniform coat of particulate material or materials in bands or strata on sheet precoated with adhesive bonding material. Patent 2,701,774 by Philip A. Marsell, and Charles H. Teller, assigned to Koppers Co. Inc.

METHOD FOR SPRAYING METAL

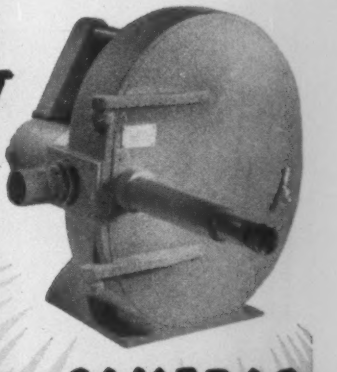
Metal is spray deposited after being fused and forcibly discharged under substantial pressure from a spray nozzle. Patent 2,701,775 by Joseph B. Brennan.

FOR THE FIRST TIME
IN ONE CAMERA

TOP PICTURE QUALITY

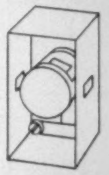
COMBINED WITH

GREATEST
SPEED
RANGE



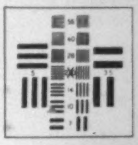
FASTAX HIGH-SPEED MOTION PICTURE CAMERAS

IMPROVED ROTATING PRISM



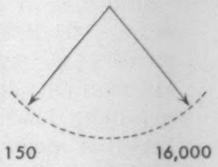
In the FASTAX, shutter operation is obtained by a multi-sided optical glass prism in synchronization with the film. Recent engineering developments have greatly improved prism operation, resulting in higher image clarity.

FINER CONTRAST . . . HIGHER RESOLUTION



Resolution tests with the improved FASTAX show excellent tonal gradations at both low and high speeds as well as evening-out of horizontal and vertical lines.

GREATEST SPEED RANGES



FASTAX cameras are the most versatile . . . have the highest speed ranges—150 to 16,000 pictures per second. For the higher speeds, FASTAX is the only high-speed camera that can solve your instrumentation problems.

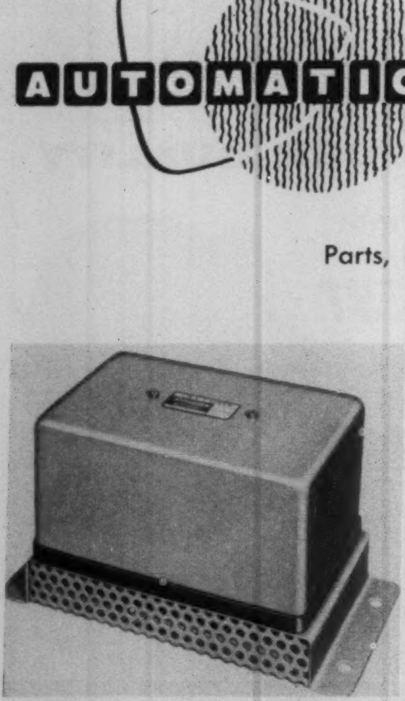
WRITE for catalog or send us your specific problems.

See the NEW, IMPROVED FASTAX . . . the camera for FINER PHOTOGRAPHIC INSTRUMENTATION

MASTERPIECES BY
WOLLENSAK
Optical Co., Rochester 21, N. Y.

AUTOMATION new components

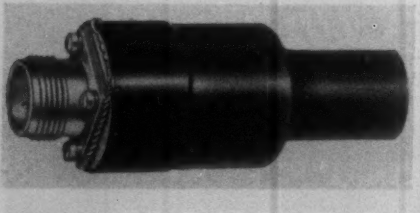
Parts, elements and devices designed for creating more automatic systems



Magnetic Amplifiers

Developed for use in control systems where a high gain amplifier and fast response are required, line of magnetic amplifiers have application either as phase reversible ac amplifiers or as polarity reversible dc amplifiers for dc inputs with no changes in the internal wiring of the amplifier. Because the speed of response is independent of the number of stages of amplification, input and output phase occur during the same half cycle of the power supply in the three-stage amplifier. Reduction of the series major loop lag permits use of more negative feedback in the inner loop. **Librascope, Inc.,** 808 Western Ave., Glendale, Calif.

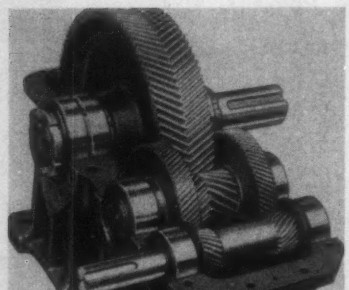
Circle No. 22 on Reply Card



Pressure Switches

Miniaturized pressure actuated switches are designed for aircraft, rocket and missile applications. Switches weigh approximately 4 oz and have an operating pressure range of 5 to 12,000 psi. Explosion proof units are housed in aluminum castings and built to withstand surge pressures. **Leach Relay Co., Div. Leach Corp.,** 5915 Avalon Blvd., Los Angeles 3, Calif.

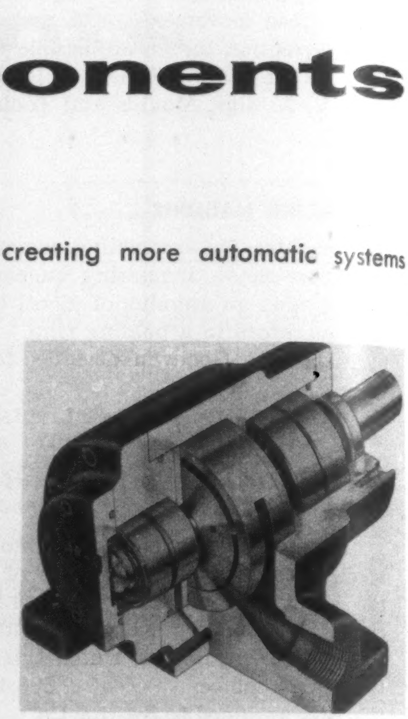
Circle No. 23 on Reply Card



Gear Speed Reducers

New line of gear speed reducers with 1 to 1950 hp range is produced in 60 standard ratios. Units are available for either coupled or overhung load applications. Features of gear speed reducers include precision generated gearing; symmetrical, balanced gearing and bearing arrangement; antifriction bearings; alloy iron housings; and large inspection openings. Nine shaft extension assemblies and two standard styles of bed plates provide various drive arrangements. **W. A. Jones Foundry & Machine Co.,** 4401 W. Roosevelt Rd., Chicago 24, Ill.

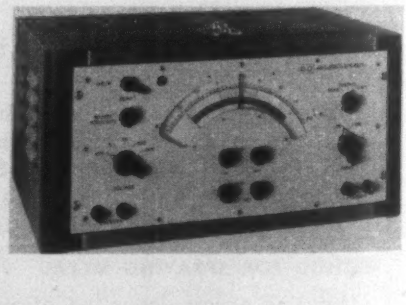
Circle No. 24 on Reply Card



Fluid Motor

Designed for continuous operation at pressures up to 1500 psi and speeds up to 3500 rpm, fluid motor is addition to line of oil hydraulic pumps, valves, boosters, reservoirs and package units. Motor features constant torque at any degree of rotation. Theoretical torque rating is 25 in.-lb per 100 psi. Bearings will withstand overhung loads equal to full torque on a 6-in. diameter wheel plus 100 lb external end thrust. **Racine Hydraulics & Machinery, Inc.,** Racine, Wis.

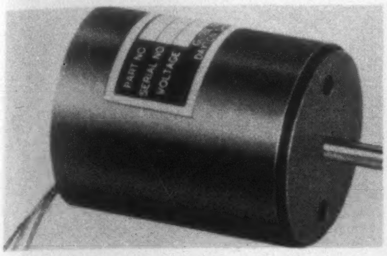
Circle No. 25 on Reply Card



Deviation Bridge

Deviation bridge uses null balance principle of operation to compare sample resistors with standard resistors of the same nominal value. When limited numbers of resistors are to be tested, operator sets the instrument to read, manually places the resistors across test clips, reads the indicator and manually places the resistor in the bin indicated. For higher production, instrument control is set to sort. Resistor is placed in a semiautomatic test fixture, and the instrument is impulsed. Resistor is automatically measured and binned. Automatic process permits production rates of 3000 per hour. **Barnes Development Co.,** 213 W. Baltimore Pike, Lansdowne, Pa.

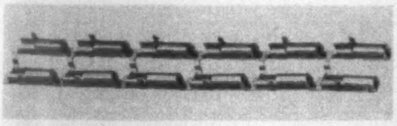
Circle No. **26** *on Reply Card*



Miniature AC Motors

New subminiature motors of 1-1/16-inch diameter are available in either 400 or 60 cycle ac models. Motors can be wound for single phase, two- or three-phase operation, and are available as an induction or hysteresis unit. Motors can be furnished with a concentric spur gear reducer. **Globe Industries, Inc.,** 1784 Stanley Ave., Dayton, O.

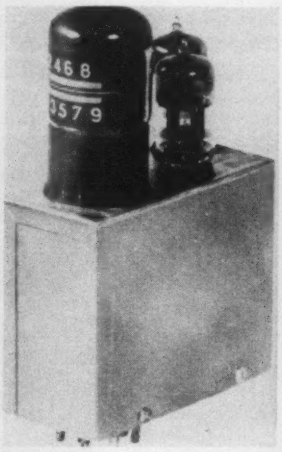
Circle No. **27** *on Reply Card*



Television Connector

New television connector is designed for automatic attachment to television cord sets by soldering or cold crimping. Connector is made of pre-tinned metal for soldered attachment. Units are produced in continuous form and supplied on reels. Machine with which they are attached cold crimps or solders and cuts off in one instantaneous operation. **Electric Terminal Corp.,** 75 Virginia Ave., Providence, R. I.

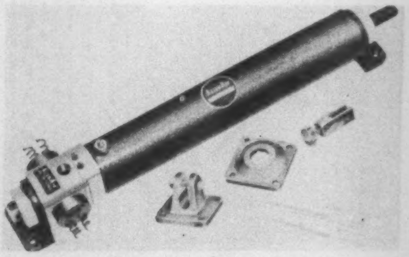
Circle No. **28** *on Reply Card*



Electronic Decade Counters

Electronic decade counters are designed for use as component parts of digital electronic computers, automatic industrial control devices and electronic measuring instruments for counting objects, motions, revolutions, length, and other physical, mechanical or optical phenomena which can be converted into electrical impulses. Counters can be used for measuring time intervals, velocity, pressure, flow, frequency, and as scintillation counters in nuclear instruments. Number of impulses occurring each second can be read on the face of the scaler tube. **Ransom Research,** P.O. Box 382, San Pedro, Calif.

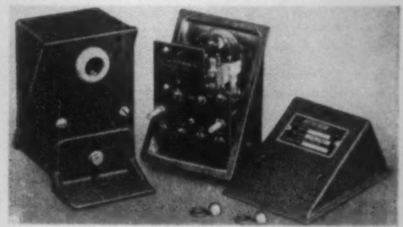
Circle No. **29** *on Reply Card*



Valve-In-Head Cylinders

New line of cylinders features integral valves in the rear head, with models available in 2 and 3-inch bores, stroke lengths up to 60 inches, with or without adjustable cushions. Built in valves have slider which is actuated by a spool whose instantaneous motion is achieved by momentarily bleeding air from either end. Illustrated model is actuated by two solenoids available for either 110 v or 8 v operation. **A. K. Allen Co.,** 57 Meserole Ave., Brooklyn 22, N. Y.

Circle No. **30** *on Reply Card*



Photoelectric Control Unit

Designed for applications where the light beam is completely interrupted, photoelectric control unit requires 20 ft-candles minimum light, with 0.06-second minimum phototube dark time and 0.06-second minimum phototube light time. When light beam is interrupted, plate relay is energized. Relay contacts are rated 5 amps at 115 v ac. Unit is available with light sources for operating distances from 2 to 30 ft. **Autotron Co.,** P. O. Box 722-RR, Danville, Ill.

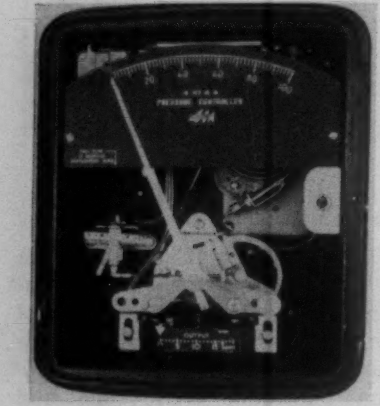
Circle No. **31** *on Reply Card*

Motor Alternator

Synchronizing a driven shaft rotation with a two-phase electrical signal, driving two-phase alternators, serving as a phase standard, and driving pulse generator wheels with two-phase sine wave voltages are among the applications of motor alternator. Input is single phase 60 cycle 115 v rated 26 to 30

w. Power output is equivalent to 2.7 w from shaft or 1.37 w electrical power. Unit features synchronous operation, dynamically balanced rotors on a stainless steel shaft and two-bearing construction. Rotor shaft, which is extended at both ends of the motor alternator, permits unit to perform several functions simultaneously. **Electric Motors & Specialties, Inc.,** King & Hamsher Sts., Garrett, Ind.

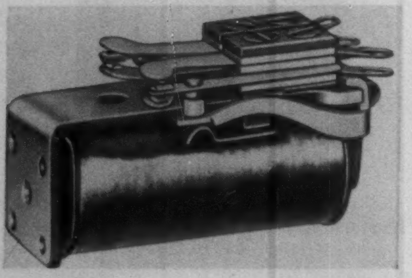
Circle No. 32 on Reply Card



Pneumatic Controller

Indicating controller provides on-off or narrow band proportional control of temperature, pressure, liquid level and humidity. For on-off action, unit snaps control valve from opened to closed when the measurement crosses the control point. Pneumatic controller uses air jet action for throttling applications. **Foxboro Co.,** Foxboro, Mass.

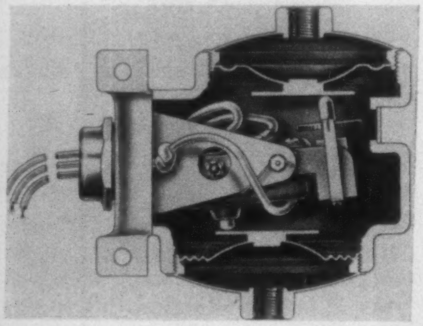
Circle No. 33 on Reply Card



Single Coil Telephone Relay

Available in 1 to 5 amp contact ratings, miniature relay offers a maximum sensitivity of 15 milliwatts per pole, withstanding 10 g vibration from 10 to 500 cycles. Beryllium copper armature retaining spring affords positive contact between armature and pivot point. Life expectancy is approximately 300,000 cycles at 1 amp inductive loads. **Advance Electric & Relay Co.,** 2435 N. Naomi St., Burbank, Calif.

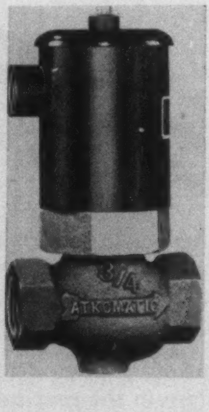
Circle No. 34 on Reply Card



Pressure Difference Switch

A new switch senses any pressure difference from 0 to 99 psi between two pressures within the working range of 0.05 to 100 psi. Switch then activates an electric circuit on increase or decrease of any predetermined pressure difference within the selected range. Unit is easily adjusted in the field with a ratchet, operates in any position, and requires no balancing or leveling when installed. The switching and sensing functions are not affected by jarring or by vibrations from pumps and compressors. Housing is splash and tamperproof. **Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.

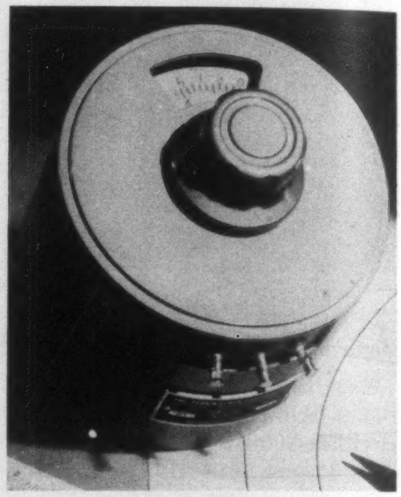
Circle No. 35 on Reply Card



Solenoid Valves

Semidirect lift solenoid valves are used with air, gas, freon, methyl chloride, water, oil and low pressure steam. When the solenoid is energized, the coil lifts the pilot valve assembly from the pilot valve orifice, relieving pressure on top of the piston. Line pressure then lifts the piston. When there is no line pressure, pilot valve assembly engages the piston directly, lifting it from the full port area, assuring positive opening even at 0 psi. Among special features of solenoid valve is glass wound, silicon impregnated coil for operation above 212F. **Atkomatic Valve Co.,** Dept. 1, 545 Abbott St., Indianapolis, Ind.

Circle No. 36 on Reply Card



Precision Voltage Divider

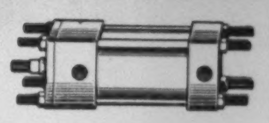
A variable-ratio transformer is essentially a combination of potentiometer and autotransformer for use in servosystems and analog computers. The tapped autotransformer provides the basic division of voltage into several discrete levels, which are then selected and further subdivided by a continuous one-turn interpolating potentiometer. Potentiometer is connected sequentially across the autotransformer so that the voltage of the potentiometer wiper is varied smoothly from one level to another. Potentiometer moves through ten turns and interpolates between 30 transformer taps. Instrument combines low output impedance with the resolution and linearity ordinarily found with high impedance multi-turn potentiometers. Pilot model's linearity tolerance is better than ±0.05 per

1722 Different Cylinder SELECTIONS—

Miller AIR AND HYDRAULIC CYLINDERS AND BOOSTERS

"IN STOCK" *for immediate delivery*

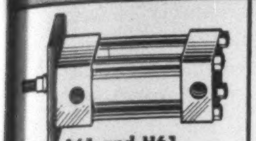
See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.



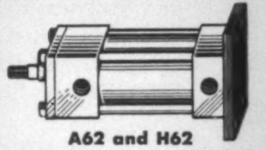
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.

"IN-STOCK" MODELS

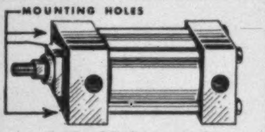
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.



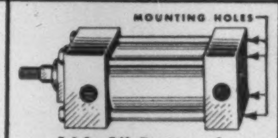
A61 and H61
Flange Mounting on Rod End



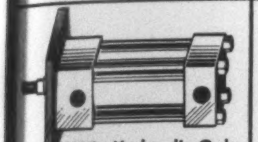
A62 and H62
Flange Mounting on Cap End



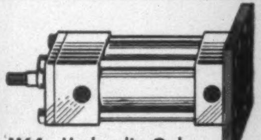
A63—8" Bore only
Flange Mounting on Rod End



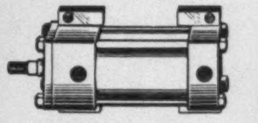
A64—8" Bore only
Flange Mounting on Cap End



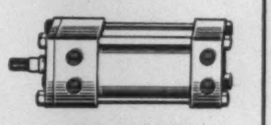
H65—Hydraulic Only
Flange Mounting on Rod End



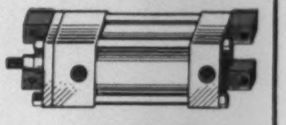
H66—Hydraulic Only
Flange Mounting on Cap End



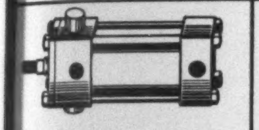
A72 and H72
Side Lug Mounting



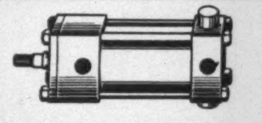
A74 and H74
Side Flush Mounting



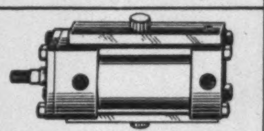
A77 and H77
Side or Foot Mounting



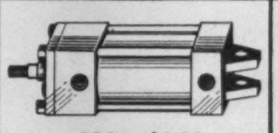
A81 and H81 Trunnion Mounting on Rod End



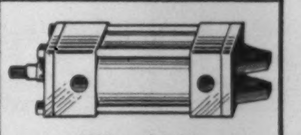
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap
(one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

		BORES	ROD DIA.	ROD TURN DOWN & THREADS	''IN-STOCK'' STROKES (in Inches)																						
IN STOCK BORES In Inches	AIR	1½	⅝"	7/16-20	Cushioned																						①
					Non-Cush.	1	2	3	4	5	6																
		2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	①
		6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	④
	HYDRAULIC	1½	⅝"	7/16-20	Cushioned																						③
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12										②
		2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	②
		4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
		5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
					Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36	
																				④					③		

"A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

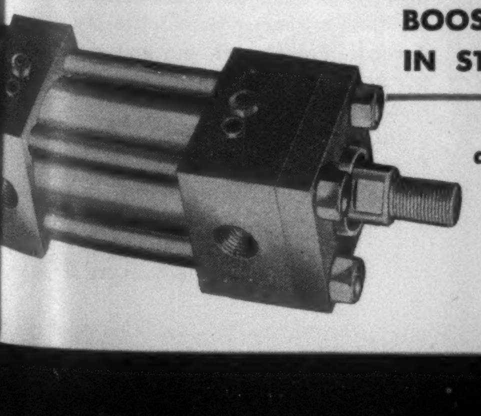
Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.

BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.



Write For Catalog and Stock Price List

MILLER FLUID POWER CO.

(Formerly MILLER MOTOR COMPANY)

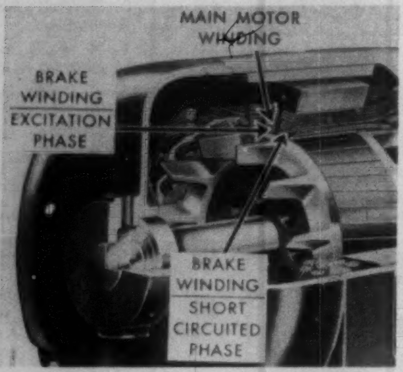
Miller

2015 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

cent, and resolution is better than 0.01 per cent at an output impedance of 130 ohms maximum. Transformer can provide an output current of 50 milliamperes and operates in the frequency range of 50 to 3000 cycles per second. **Vernistat Div., Perkin-Elmer Corp.,** Norwalk, Conn.

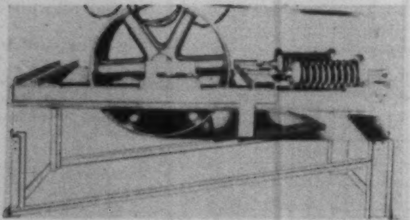
Circle No. 37 on Reply Card


MAIN MOTOR WINDING
BRAKE WINDING EXCITATION PHASE
BRAKE WINDING SHORT CIRCUITED PHASE

Dynamic Brake Motor

New type ac dynamic brake is built into standard frame size single or polyphase induction motors. Multipolar, two-phase brake windings are super-imposed on standard stator winding. One phase of brake winding is connected to single phase line during braking operation; second phase, permanently short-circuited and never connected to line, receives power from rotor between synchronous and zero speeds. Brake motors are available up to 30 hp, with larger sizes being developed. **Master Electric Co.,** 126 Davis Ave., Dayton 1, O.

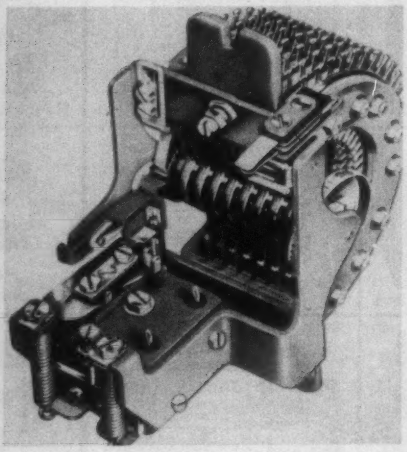
Circle No. 38 on Reply Card



Conveyor Components

Pre-engineered packaged components enable users of steel belt conveyors to engineer a conveyor by selecting the correct components to meet given requirements. Typical packaged components include drive end and tension end assemblies, steel belts, discharge devices, safety devices and loading hoppers. Several types and sizes of various components are available. Pre-engineered units are said to eliminate detail design work and avoid trial-and-error methods. **Sandvik Steel Belt Conveyors, Div. Sandvik Steel, Inc.,** 111 Eighth Ave., New York 11, N. Y.

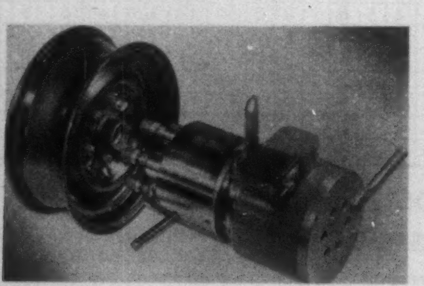
Circle No. 39 on Reply Card



Heavy Duty Stepping Switch

Designed for heavy duty operation, stepping switch can be used with line finders, registers, and time switches. When fitted with up to eight double-ended or ten single-ended wipers, approximate stepping speed is 60 steps per second. Coil range covers 22, 40, 50 and 60v dc operation. Bank contacts, wipers, collector rings and brushes are made of nickel silver for wear resistance. **Imtra Corp.,** 58 Charles St., Cambridge 41, Mass.

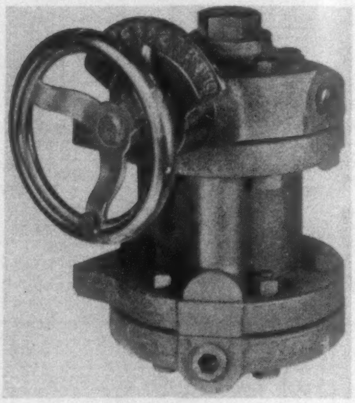
Circle No. 40 on Reply Card



Torque Wrench

Called "Pow-OR-Tork", magnetic release torque wrench operates first as a nut runner and then as a torque wrench until fastener reaches predetermined torque when it automatically releases. Wrench is said to eliminate errors resulting from overcoming alternate static and dynamic friction during the tightening cycle, from misreading of gages, and from distortion and breakage of parts. Wrench is available in sizes ranging from those suitable for clocks and instrument assembly to large industrial installations such as bridge work. **Ohlsson & Rice, Inc.,** 3340 Emery St., Los Angeles 23, Calif.

Circle No. 41 on Reply Card



Constant Flow Valve

New series of flow valves maintains the rate of flow of fuel oil or any nonabrasive fluid within 1 per cent up to 200, 300, 400, 500, 600, or 700 gph as desired. Flow level may be set manually at the valve or through any one of four remote adjusting systems designed to operate in conjunction with the valve. Four systems, one hydraulic, one pneumatic and two electric, may in turn be operated manually or by a pneumatic or electric signal proportional to temperature, flow of another fluid or a gas. Among applications of flow valve are manual regulation of flow according to a variable such as temperature, proportioning of several flows and summarization of several fuel flows to control quantity of air delivered to the point of combustion. **Askania Regulator Co.,** 240 E. Ontario St., Chicago 11, Ill.

Circle No. 42 on Reply Card

As a companion to its line of Type M Unibrake Motors with magnetic braking . . . Master now offers a line of Type D Unibrake Motors with dynamic braking.

HOW IT WORKS. Dynamic braking is obtained with a patented* unique, multi-polar brake winding superimposed on the stator winding of any Master single-phase or polyphase induction motor.

ADVANTAGES. Unibrake motors with dynamic braking are very compact, usually no larger than the standard motor. And since the dynamic brake has no moving parts, there is no wear . . . nothing to adjust . . . braking torque remains uniform.

INCREASE PRODUCTION. Don't waste valuable production time waiting for machinery to coast to a stop . . . get quick slow-down for machine tool spindles . . . quick turn-around time on many operations . . . speed up automatic cycling of machinery. And since Type D Unibrake Motors come to a rolling stop, they are particularly adaptable to equipment requiring gear shift between cycles.

SIZES. Now available up to 30 horsepower . . . larger ratings are being developed. Master Gearmotors and variable speed drives can also be supplied with Type D Unibrakes.

LITERATURE. For complete information write for Data 3810.

THE MASTER ELECTRIC COMPANY • DAYTON 1, OHIO

Now

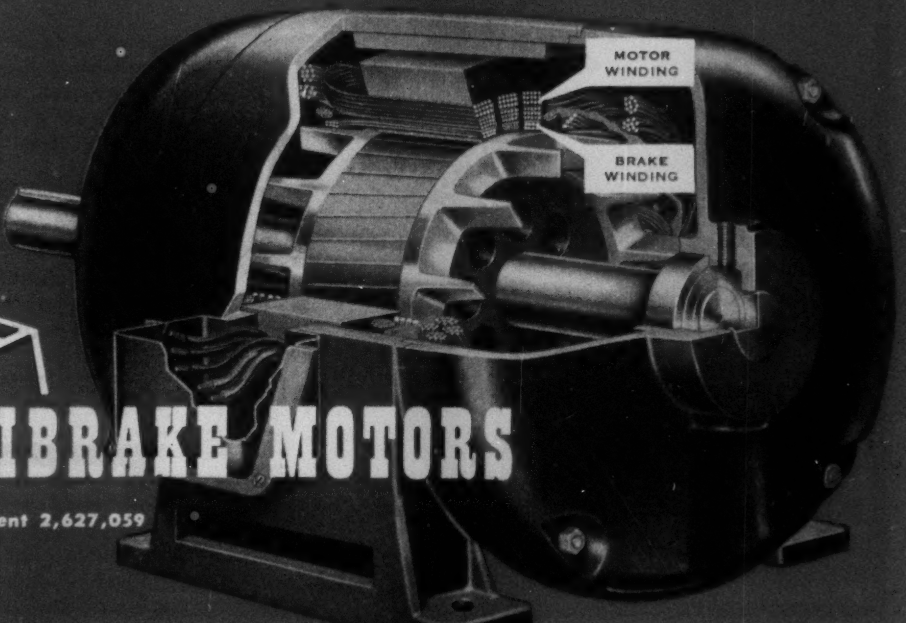
DYNAMIC BRAKING

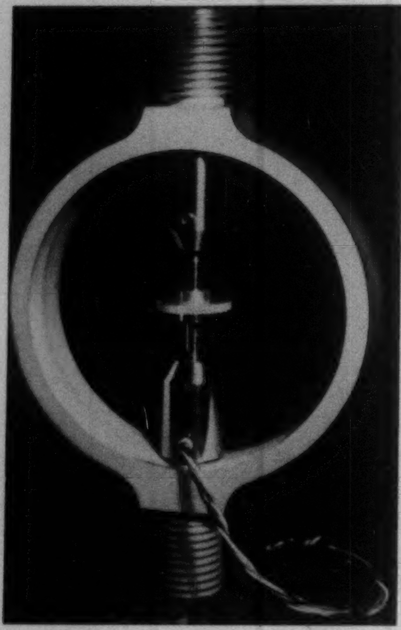
for A-C motors

MASTER

UNIBRAKE MOTORS

* U. S. Patent 2,627,059





Load Transducers

Static or dynamic values of weight, force, compressive stress or tensile stress are transmitted by new line of load transducers. Based on the differential transformer principle for measuring minute displacements of an iron core in an inductive field, transducers feature 1 per cent linearity, a frequency range from zero to 1000 cycles per second, and stability of calibration and zero point. **Daytronic Corp.,** 216 S. Main St., Dayton 2, O.

Circle No. 43 on Reply Card

9
8
7
6
5
4
3
2
1
0

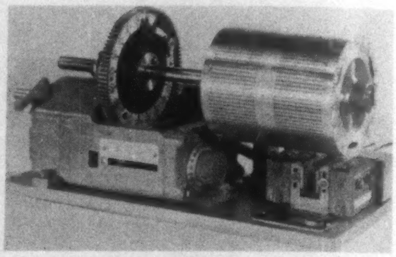
Decimal Counting Instrument

Capable of counting and displaying in direct-reading digital form any data that can be represented by minute changes in electrical voltage, the basic model in a line of decimal counting units has had counting rate increased to 100,000 counts per second. Three basic models in production now have count rates of 100,000, 350,000, and 1 million counts per second. Units are applicable to electronic counting, measurement, and nuclear scaling instruments. **Berkeley Div., Beckman Instruments, Inc.,** 2200 Wright Ave., Richmond 4, Calif.

Circle No. 44 on Reply Card

Automatic Counter Switch

Designed to recycle sequence



Another FEEDALL AUTOMATIC UNIT

BAR FEEDER MODEL 1700B

Designed to feed bars and tubes to centerless grinders, polishing machines, heat treating and hardening equipment, etc. this Model 1700 B Unit conveys parts at any desired, constant speed of 5 to 20 ft. per minute from the hopper to the machine.

Cycling control can be either photoelectric relay or mercury switch. Parts can be delivered as illustrated or at right angles by the use of special tooling.

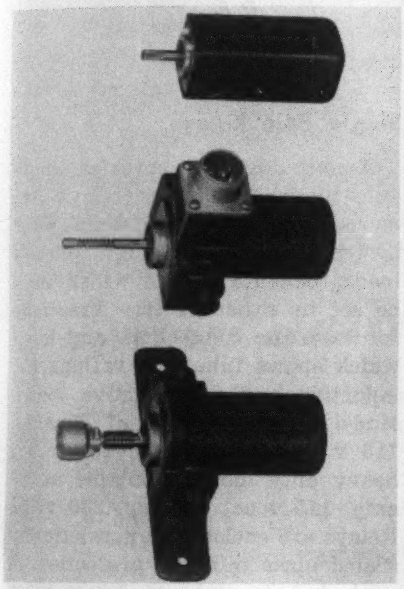
This Model handles parts ¼″ to 1½″ in dia. and 6″ to 26″ length. Other Models are available up to 5 foot lengths and with various rates of feed.

There are many Models of FEEDALL Feeders. Tell us your problems for suggestions and quotations.

FEEDALL
INCORPORATED
WILLOUGHBY, OHIO, U. S. A.

switching, automatic counter provides intermediate switching points within count cycle, counts revolutions, strokes or electric impulses, and operates at speeds up to 4000 rpm. Intermediate switching points are determined by response of sensing switch actuators to a pattern on a program cylinder which alternately traverses two switches. Reversal of cylinder movement is accomplished by a clutching action. Basically a single circuit controller, counter may be used for multi-circuit requirement by working through a stepping relay. **Counter & Control Corp.,** 5213 W. Electric Ave., Milwaukee 14, Wis.

Circle No. 45 on Reply Card



Miniature Electric Motors

Three miniature electric motors for actuators and similar high speed applications weigh less than one pound each. One is a split series type unit for 24v dc or 110v ac, rated at 2.5 oz-in. for intermittent duty to 160F. It is available for unirotational and reversible operation, with or without integral filter, measures 3 x 3 x 2½ inches. A second square motor type is rated at 4 oz-in. torque for intermittent duty to 165F, is a split series 24v dc model. This motor can be furnished for unirotational or reversible operation, with or without magnetic brake, and for use in ambient temperatures up to 275F. Motor is 1 inch square and

First in performance for automatic muscle jobs like these...

T-J **Spacemaker** CYLINDERS

OFF SHELF DELIVERY

PUSH
PULL
LIFT

- OIL pressure to 750—AIR to 200 P.S.I.
- New Compact Design . . . Saves up to 40% Space
- Proven Performance . . . with Extra High Safety Factor
- Super Cushion Flexible Seals for Air . . . New Self-Aligning Adjustable Oil Cushion
- Hard Chrome Plated Bodies and Piston Rods
- The Only Cylinders with all the Extras as Standard

T-J Spacemaker Cylinders get first call for an ever-widening range of power movement jobs in industry today—because they're so advanced in design . . . so efficient and dependable in performance. Wide selection of styles and capacities. Check your needs now! Send for bulletin SM-454-2. The Tomkins-Johnson Co. Jackson, Mich.

Raise
Lock
Brake
Press
Spin
Turn
Grind
Weld
Lower
Squeeze
Bend
Coin
Saw
Tap
Index
Braze
Open
Time
Blank
Cut
Broach
Drill
Sequence
Close
Snub
Form
Pierce
Feed
Mill
Convey
etc.

T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Member of the National Fluid Power Association

T-J TOMKINS-JOHNSON

RIVITORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS

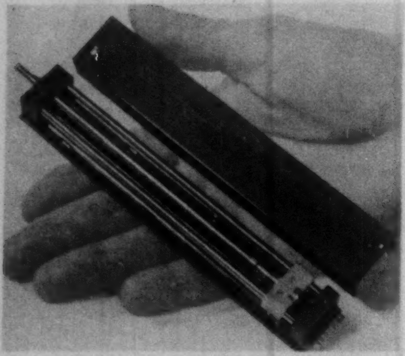
2 inches long. A third, shut field type, 24v dc motor is unirotational only, is rated at 1 oz-in. for continuous duty to 160F. This model incorporates thermistors in the field to compensate for temperature effect on motor speed. **Pacific Div., Bendix Aviation Corp.,** 11600 Sherman Way, North Hollywood, Calif.

Circle No. **46** *on Reply Card*

Servometer

High gain servoamplifier and an aircraft type instrument panel indicator comprise the servometer. Unit is designed for resistive bridge type sensing elements such as pressure gages, accelerometers and mechanical force measuring devices. Sensing element output is amplified by a high gain nonlinear amplifier which drives a servomotor within the indicator. Voltage range is 105 to 125v; frequency variations are from 300 to 450 cycles per second. When combined with a digital converter, servometer will furnish digitized information for local recording purposes. **Radiation Inc.,** Melbourne, Fla.

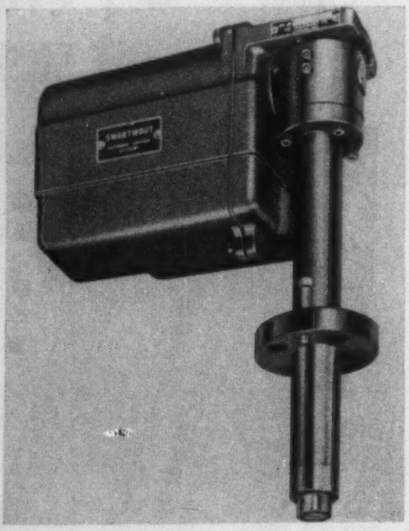
Circle No. **47** *on Reply Card*



Linear Motion Potentiometer

Designed for recording and control instrumentation, wire wound linear motion potentiometer accurately translates mechanical position into an electrical signal. Called "Linipot", new potentiometer features a zero based linearity of ±0.05 per cent with a 4-inch stroke (shaft displacement). Operating force of 1 oz makes Linipot well suited for use in servosystems. **Benson - Lehner Corp.,** 2340 Sawtelle Blvd., Los Angeles 64, Calif.

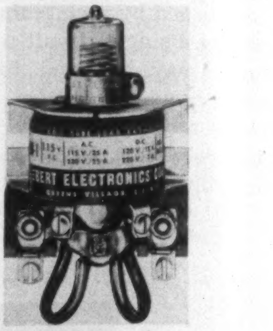
Circle No. **48** *on Reply Card*



Diaphragm Pressure Transmitter

Stagnant pressure lines are eliminated in a new pressure transmitter, which is designed for use with company's Autronic electronic control system for polymers, asphalts, slurries, and molten metals which solidify when stagnant. All parts of the transmitter which contact the fluid are made of stainless steel. The pressure measuring diaphragm is mounted inside a well mounted on the pipe line so that its surface is flush with the inside of the pipe wall. This permits free movement of the diaphragm but does not restrict process flow in the pipe, consequently eliminates stagnant pressure lines. The diaphragm's movements, in response to pressure changes, are transmitted through a rod to a mechanical linkage which actuates the core of a differential transformer. The resulting output signal, varying from 0 to 0.5v, 60 cycles ac, is directly proportional to the pressure being measured. Transmitter is used with recorders or controllers in the pressure ranges of 0-200 to 0-1000 psig, and 0-1000 to 0-2500 psig for operation at temperatures up to 300C. Sensitivity is better than 0.005 per cent, and accuracy is 1 per cent. **Swartwout Co.,** 18511 Euclid Ave. Cleveland 12, O.

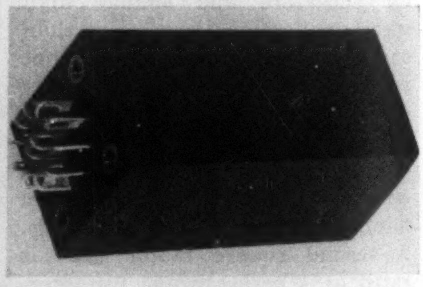
Circle No. **49** *on Reply Card*



Single Pole Relays

Among design features of single pole mercury plunger relays are mercury cups made of alumina for protection against high inrush loads, bakelite blocks which may be set in either of two directions for load line connection, and label which shows tube load ratings for inductive and noninductive loads. Model shown is rated at 35 amp, 115 v ac and 25 amp, 230 v ac; heavy duty model available at 60 amp, 115 v ac; 35 amp, 230 v ac. Relays are enclosed in hermetically sealed glass tube for protection in explosive atmospheres. **Ebert Electronics Corp.,** 212-26 Jamaica Ave., Queens Village 28, L.I., N.Y.

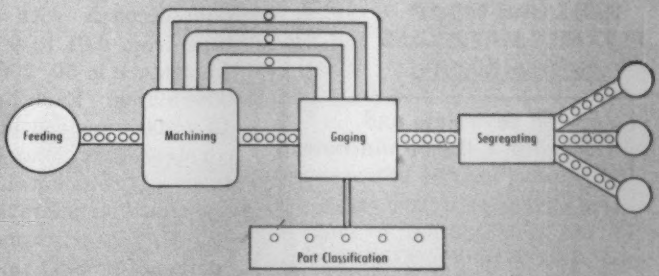
Circle No. **50** *on Reply Card*



Tapped Delay Line

A new series of tapped delay lines is offered in 46 different combinations of delay times and characteristic impedances. Total delay

AUTOMATION DEMANDS *RELIABLE CONTROLS*



Dimensional control is the very heart of automation for the metalworking industry. Consequently, care in the selection of In-Process and Post-Process control devices is very important.

As a long recognized leader in air, electric and electronic gaging, Sheffield is prepared to furnish either:

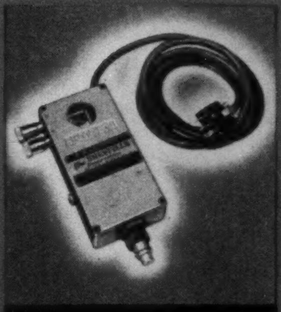
- Packaged controls and tooling ready to install
- Complete automation gaging and transfer systems ready to operate

FUNCTIONS and ADVANTAGES

- Determine minute dimensional variations, rapidly and with repetitive precision
- Initiate warning signals
- Actuate control mechanisms
- Segregate acceptable, oversize and undersize parts
- Accurately classify parts by sizes
- Accommodate almost limitless range of tolerances
- Operate with interchangeable tooling
- Are small, compact and easily mounted
- Have unusually long, trouble-free service life
- Are easily interchanged

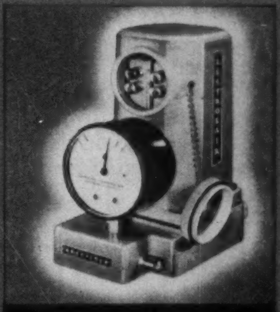
7125

Shown here are a few of those Sheffield control units so widely used in automated systems.



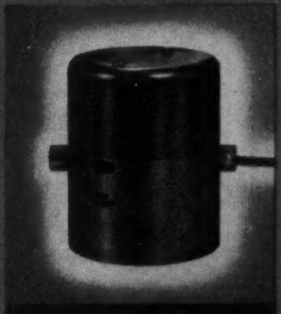
AIRLECTRIC

A limit type pneumatic control to actuate signals and relays.



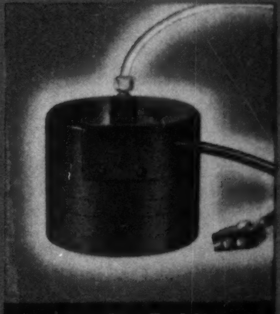
LECTROLAIR

A sealed-in control to actuate signals and relays and also to give visual size indication.



DIFFERENTIAL

A gage head for checking taper, hole parallelism or hole center distance and converting the result into an actuating electrical impulse.



VARIATION

A pneumatic gage head for external or internal dimensions and face to axis runout—converts the result into an actuating electrical impulse.

See us at the
Machine Tool Show, Booth 1305

For more detailed information, write for Bulletin AU-1154

The Sheffield Corporation
Division 500
Dayton 1, Ohio, U.S.A.

MASTER CRAFTSMAN
SHEFFIELD
HEADQUARTERS

SHEFFIELD

ROLL and WRAP FLEXIBLE MATERIALS *automatically*

You can save time and labor with a Dyken machine if you roll lengths of

SCREENING • LAMINATED PAPER TEXTILES • ROOFING • RUGS • WALLPAPER • CARPETING • PLASTIC • RUBBER • LEATHER FELT • LINOLEUM • CANVAS CORK • PADDING • OILCLOTH BURLAP • INSULATION

and other pliable materials!

ONLY A DYKEN Rolling Machine will roll (or roll and paper-wrap) lengths of flexible material ... *without requiring center cores, starting bars or mandrels.* Automatic starting. Push-button control permits using unskilled operators. Compact rolls save storage and shipping space. Standard machine models available for all material widths and lengths. Fully patented.

WRITE TODAY FOR COMPLETE DETAILS—Describe your problem fully for recommendations by our engineers. No obligation.

DYKEN MFG. CO., Inc.
742 Indiana Ave.
West Bend, Wis.

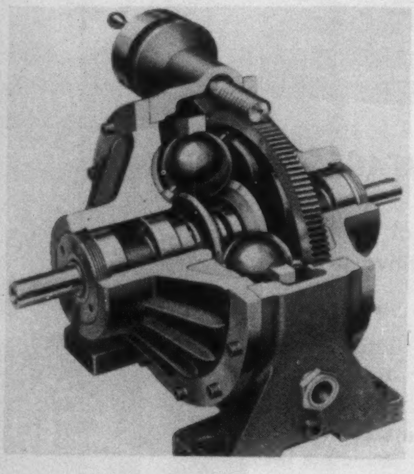
what article

in this issue would you like to have in your file? Just circle the page number on the reply card* and we'll do the rest.

* THIS SERVICE IS FREE. See page 96

times available range from 0.1 to 7 microseconds, with delay between taps from 0.01 to 0.7 microsecond. Impedance is 50, 200, 500, 1000, or 2000 ohms. Each line is tapped at 10 equally spaced points. Lumped-constant type delay lines meet military environmental requirements, operate in temperatures of −55 to 125 C. Four tapped inserts accommodate 6-32 mounting bolts, external connections are via solder lugs. Units are capsulated in a special, stable thermosetting resin which surrounds and supports each component, protecting it against shock and vibration. They are hermetically sealed, and have excellent thermal stability of delay. Each unit measures 1¼ x 1¼ x 2 13/16 inches, and weighs 4 oz. **Jacobs Instrument Co.,** Bethesda 14, Md.

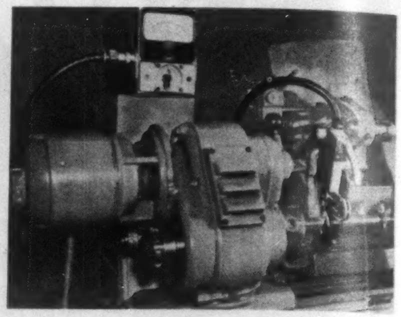
Circle No. 51 *on Reply Card*



Variable Speed Drive

Speed Variator is available in nine sizes ranging from ½ to 10 hp at 1750 rpm input. Power is transmitted from the input shaft to the output shaft through alloy steel driving balls which are in pressure contact with disks attached to the two shafts. The relative speeds of the shafts are adjusted through a 9:1 range by changing the angular positioning of the axles on which the balls rotate. This permits an infinitely variable and stepless range of output speeds from one constant speed power source. Co-axial input and output shafts rotate either clockwise or counterclockwise, both in the same direction. There is no complicated linkage, and no drift is reported. Speed may be regulated by manual adjustment, by indicator, or by manual or power operated remote control devices. **Cleveland Worm & Gear Co.,** 3249 E. 80 St., Cleveland 4, O.

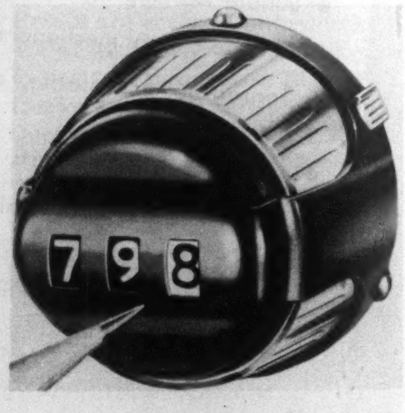
Circle No. 52 *on Reply Card*



Electronic Micrometer

Capable of automatically controlling a grinding machine's cycle and guaranteeing tolerances as low as 0.00005-inch, electronic micrometer can be set up on almost any machine in approximately 15 minutes. Size, taper and form tolerances are indicated on dial, and when piece is down to final size, the wheel retracts automatically. **Industrial Gauges Corp.,** Englewood, N. J.

Circle No. 53 *on Reply Card*

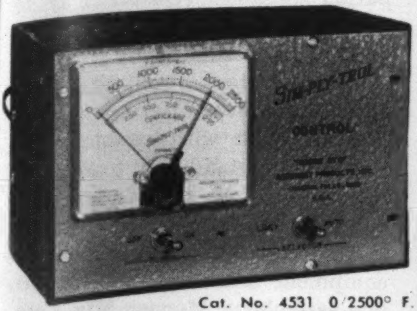


High Speed Precision Dial

New direct reading, high speed precision dial, called Model 1301 Microdial, is designed for manual or servomotor operated multiturn devices, and is applicable to potentiometers or any rotating device of 3600° or less. Direct reading window numerically indicates shaft or wiper position to three

(Advertisement)

SIMPLYTROL AUTOMATIC PYROMETER



10 temperature ranges cover from -75° to 3000°F.

Several special ranges to -400°F.

Cat. No. 4531 0/2500° F.
Price $132.00

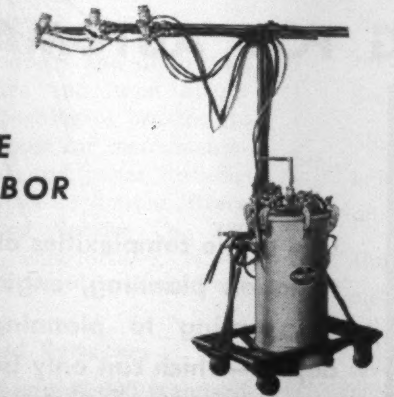
Thermocouple type Automatic Pyrometer for controlling temperature in furnaces, ovens, and processes. The Simplytrol is economical and reliable with few moving parts. There are no vacuum tubes. The regular load relay is S.P.D.T. 5 Amps. Optional heavy duty relays to 40 Amps.

10 temperature ranges cover from −75° to 3000° F. Several special ranges to −400° F. "On & Off" control for holding the desired temperature works on gas, oil or electric heat. Indicating meter-relay is medium high resistance and has bimetal cold junction compensation. For use with all standard thermocouples. Accuracy 2%.

"Auto-Limit" switch changes Simplytrol from automatic controller to limit pyrometer for safety shut down or warning. Cabinet: 6½x6½x9½ inches. Also flush panel mount models. Send for new Bulletin G-7 for more data. Assembly Products, Inc., Chesterland 27, Ohio.

"See us at I.R.E. Conf. Westward Ho, Phoenix, 4/28,29"

HAMILTON AUTOMATIC SPRAY



SAVE LABOR

Automatically

SPRAY
DRAWING COMPOUNDS

Hamilton *Inc.*
Automation

1490 EDISON AVE. ③ HAMILTON, OHIO

Streamline YOUR Small Parts Handling System . . .

it Nests
it Tiers

with NESTIER

the pre-engineered materials handling containers designed for use throughout the plant . . . . .

Eliminate costly rehandling . . . increase production efficiency . . . reduce loss and damage . . . with NesTier materials handling equipment. This complete line of specially-designed and standardized boxes, baskets and integrated equipment gives you the most efficient system available today for handling small and medium size parts.

With a pre-engineered NesTier system, you can solve basic problems in all types of parts handling operations. NesTier boxes and baskets eliminate rehandling from one container to another . . . can be used from receiving through production to stores and shipping. Manufactured to close tolerances, these versatile units also permit batch-weighing for production or inventory control. In addition, NesTiers can be used for temporary or permanent storage applications without the use of shelving.

For the Complete NesTier Story, Write Today for Your Free Copy of New Catalog DN-1000.

C-199-DN

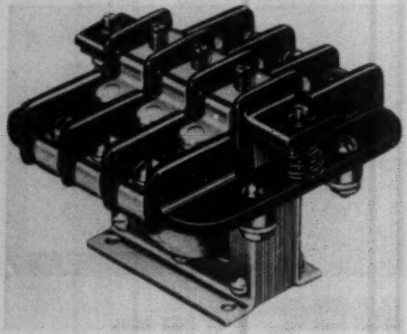
NESTIER®

. . First in small parts handling

The Chas. Wm. Doepke Mfg. Co., Inc.
8806 BLUE ASH ROAD • ROSSMOYNE, OHIO

places. Dial may be operated manually or mechanically at speeds up to 100 rpm, and indicates complete turns, tenths of turns and hundredths of turns. It is calibrated to an accuracy of 1 part in 1000. Microdial is less than 2 inches in diameter, has maximum height of 1⅝ inches. **Borg Equipment Div., George W. Borg Corp.,** Janesville, Wis.

Circle No. **54** *on Reply Card*



AC Circuit Control Relay

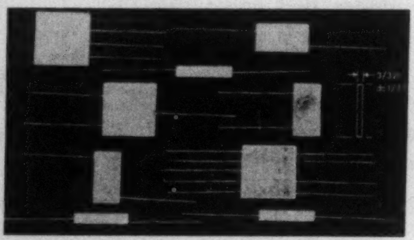
Compact, lightweight, rugged relays handle heavy contact loads with low coil power requirements in electrical and electronic control applications. Insulation, spacing, and contact life exceed UL requirements for industrial control equipment. Fine silver contacts are 3-pole, single-throw. Coils are 6 to 230v ac, 50 or 60-cycle, continuous duty, and are vacuum varnish impregnated. Relay is rated at 30 or 20 amp, resistive and inductive, 115 or 230v ac. Dimensions are 3 x 3⅛ x 2¼-inches, and weight is approximately 14 oz. **Leach Relay Co., Div. of Leach Corp.,** 5915 Avalon Blvd., Los Angeles 3, Calif.

Circle No. **55** *on Reply Card*

Precision Wire Resistors

Noninductive wire resistors feature flat, rectangular construction. Advantages of this design are minimization of space required by the unit, more rapid heat dissipation because resistor may be laid flat on a metal chassis, and ability for other fully insulated components to be built or stacked over the resistor. Units in this line are available with resistances in the range of 1/10 ohm to 2½ megohm. Resistors are designed for use with test instruments, meters, communications and scientific equipment and electronic products and assemblies. **Monson Mfg. Corp.,** 6059 W. Belmont Ave., Chicago 34, Ill.

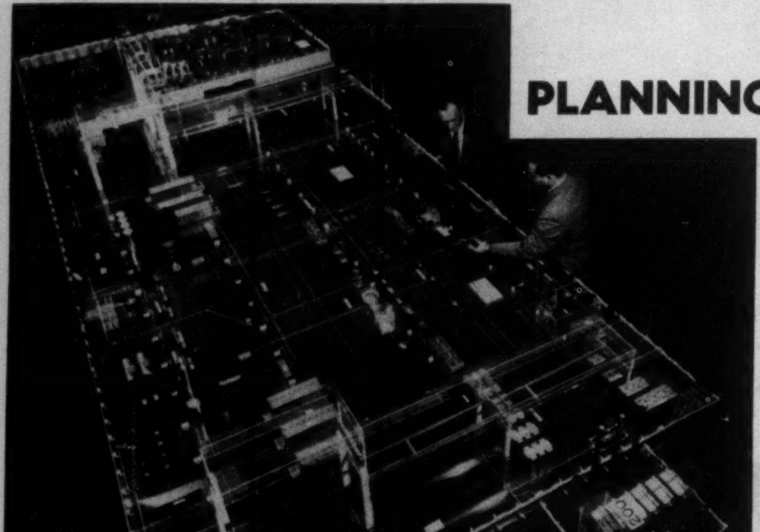
Circle No. **56** *on Reply Card*



Midget Resistors

for miniature, high wattage, wire wound stability service have a low temperature coefficient and are applicable to computer summing networks requiring components with consistent retrace grouping after many temperature cycles and a close limit on retrace runout. **British Electronic Sales Co.,** 23-03 45th Rd., Long Island City, N. Y.

Circle No. **57** *on Reply Card*



PLANNING FOR AUTOMATION!

Due to the complexities of automation planning, engineers are turning to planning in depth—which can only be accomplished through the proper utilization of 3-dimensional models.

You may secure a 3-dimensional layout of your specific plant, and its equipment, for a price ranging from 03c to 07c per square foot. For further details write:

"VISUAL" PLANT LAYOUTS, INC.
1 PENNSYLVANIA AVE., OAKMONT (ALLEGHENY COUNTY) PENNSYLVANIA

Miniature Variable Inductors

are protected against moisture and chemical attack and made resistant against the effects of large amplitude vibration or shock by the imbedment of the entire powdered carbonyl-iron cup core and coil assembly in epoxy resin. **Levinthal Electronic Products, Inc.,** 2723 Fair Oaks Ave., Redwood City, Calif.

Circle No. **58** *on Reply Card*

Leakproof Pumping

New line of 5 and 7½ hp pumps is designed for use at heads to 195 ft and capacities to 300 gpm. **Chempump Corp.,** Station C, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **59** *on Reply Card*

Snap Action Switch

for mobile, aircraft and marine applications where small size, lightweight and environment-proof construction are required, is rated at 30v dc, 2.5 amperes inductive, 4 amperes resistive with a maximum inrush of 15 amperes. **Micro Switch Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill.

Circle No. **60** *on Reply Card*

Hose Couplings

of quick connect and disconnect design, feature one hand operation without turning or twisting to lock, are designed for instrumentation, manifold and panel installation where space is limited. **Breco Div., Perfecting Service Co.,** 332 Atando Ave., Charlotte 6, N. C.

Circle No. **61** *on Reply Card*

Bantam Speed Reducers

available in any of 600 standard ratios for flow controls, computers, timers, and oscillographs, have anti-backlash feature. **Metron Instrument Co.,** 432 Lincoln St., Denver 3, Colo.

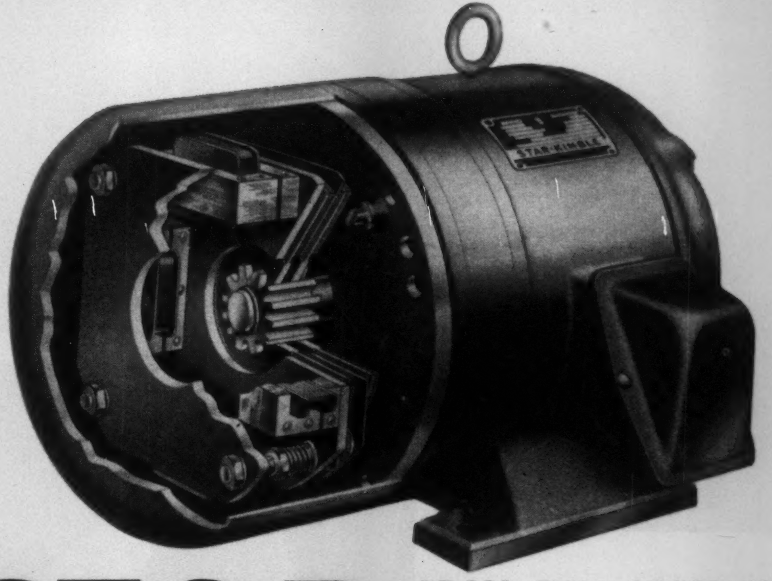
Circle No. **62** *on Reply Card*

Fluid-damped Rate Gyro

designed for use in aircraft and missile control or telemetering, is enclosed in a hermetically sealed, oil-filled case. **G. M. Giannini & Co., Inc.,** 918 E. Green St., Pasadena 1, Calif.

Circle No. **63** *on Reply Card*

START QUICKLY, SMOOTHLY, without BRAKE DRAG!



STOP FROM FULL SPEED IN A SPLIT SECOND!

WITH STAR-KIMBLE BRAKEMOTORS

Time from full speed to standstill can be as short as *one-fifth of a second* with a Star-Kimble Brakemotor — the *extra-large* brakelining area makes possible these *extra-fast* stops of motor and connected load.

Starting of the motor is fast and smooth, too. The small air gap results in instantaneous release of the brake when the motor current is switched on. No brake drag to impede acceleration.

These cycles of split-second stops and smooth starts can be repeated millions of times — that's proved by the experience of user after user of Star-Kimble motors, even in the severest types of service. In reversing service, a Brakemotor can make four times as many starts a minute as a motor which is reversed by plugging.

Every Star-Kimble Brakemotor is an integral, space-saving unit — with motor and brake designed and built together to work together. A single manufacturer — undivided responsibility.

For the full story, write for Bulletin B-501-A

STAR-KIMBLE
MOTOR DIVISION OF
MIEHLE PRINTING PRESS AND MFG. CO.
222 Bloomfield Ave. **Bloomfield, N. J.**

Planet apron conveyor moving through tunnel beneath trim presses.

THIS 1200 FT. PLANET CONVEYOR moves 20 tons of scrap per hour!

At a leading automobile plant . . . this Planet conveyor automatically handles the loose scrap from trim presses with a combined capacity of over 4,000 **tons.**

Over 20 **tons** of scrap per hour drop on a Planet hinged-pan apron conveyor as it moves through a tunnel under the presses. Moving to an automatic baler, the scrap is compressed into 2′ cubes. Then the baled scrap moves on a Planet pusher bar conveyor direct to the waiting railroad cars. A simple clutch-operated auxiliary drive assures continuity of operation.

Because baled scrap is worth more . . .
Because the entire operation is automatic . .
Because this scrap-handling system saves time and labor . . .

● It PAID this manufacturer to "Plan with Planet." It will pay you too! Better write today!

PLANET CORPORATION
1810 SUNSET AVENUE
LANSING, MICHIGAN

- CONVEYORS
- ENGINEERED SYSTEMS
- FOUNDRY EQUIPMENT
- AUTOMATION
- STEEL FABRICATION

Level Differential Monitor

operates on bubble tube principles of differential static pressure to measure or maintain a limited level differential between two points. Designed for use in chemical, sewage, utility, power generation and similar operations. **Thermo Instruments Co.,** 1310 Old County Rd., Belmont, Calif.

Circle No. **64** *on Reply Card*

Recording-Controller

has either two-position or pulse-proportional temperature control action, is designed for use with electric or electric-pilot pneumatic type two-position valves, contactors or heavy duty load relays. **Thermo Electric Co., Inc.,** Saddle River Township, Rochelle Park Post Office, N. J.

Circle No. **65** *on Reply Card*

Speed Regulated Motor

for operation under the most adverse environmental conditions described in standard military specifications, is rated at 1 hp, 28 v dc, 12,000 rpm capable of maintaining ± 6 per cent speed variation over an input voltage range from 25 to 29.5 v. **Dalmotor Co.,** 1304 Clay St., Santa Clara, Calif.

Circle No. **66** *on Reply Card*

Multiple-Point Pyrometer

which can be used with a recorder without cable changes, facilitates change of reference-junction compensators in changing thermocouples. **Bristol Co.,** Waterbury 20, Conn.

Circle No. **67** *on Reply Card*

Roller Stock Pusher

consists of a prefabricated spring-loaded roller cartridge unit which can be installed in a die set to align strip stock against the back gage in progressive and compound dies. **Applied Mechanics Corp.,** Grand Rapids, Mich.

Circle No. **68** *on Reply Card*

Linear Filled Thermometers

with large torque and high speed response, new line of vapor-pressure actuated systems is for use with partial range and short span automatic controllers. **Bristol Co.,** Waterbury 20, Conn.

Circle No. **69** *on Reply Card*

put
more bounce
in your business

Produce in

GREATER MIAMI

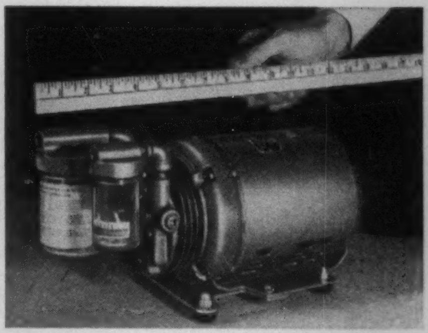
DADE COUNTY

Specialized light manufacturers have discovered they can work, play and produce profits with a livelier zest for living!

Success of these manufacturers—and more to come—is largely due to Greater Miami's unlimited labor pool, billion-dollar-plus South Florida market, strategic hemispheric location, and pleasant, uncrowded living conditions.

Investigate! Write for **free fact file:**
Greater Miami
Industrial Development Board
Post Office Box 589, **Dept. 2B** Miami 31, Florida

NEW GAST Model 0211 AIR PUMP weighs 1/3 less — is a truly



COMPACT COMPONENT

This *new* Gast rotary-vane Air Pump offers many advantages, including: 1/3 less weight — (now 22 lbs.) — with more compact, streamlined design. Rotor mounted on new G. E. Form "G" motor shaft. Vanes give positive, pulseless air delivery. Rubber-cradled mounting dampens vibration, increases quiet.

Model 0211 produces up to 25 p.s.i. or 27" vac., or 1.3 c.f.m. running open. 1/6 h.p. motor uses only 3.8 amps. Ideal for automatic machines, industrial instruments and controls. Present uses: paper feeding in packaging, printing frames, or as portable laboratory air source.

Let *your* product benefit from this compact component — *write for Bulletin 1254 and "Application Ideas" Booklet!* Gast Manufacturing Corp., P.O. Box 117-E Benton Harbor, Michigan.

Original Equipment Manufacturers for Over 25 Years

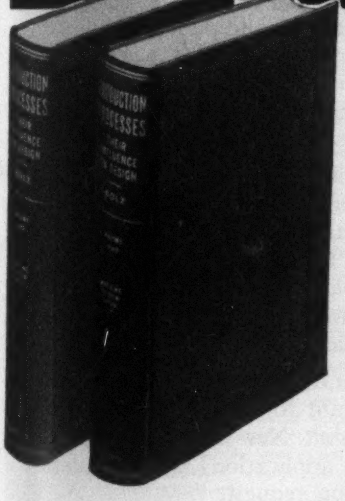
GAST ROTARY
- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

See Our Catalog in Sweet's Product Design File

"PRODUCTION PROCESSES"...

THEIR INFLUENCE ON DESIGN . . . VOLS. I & II by Roger W. Bolz

HERE'S HOW TO ACTUALLY DESIGN FOR LOW-COST PRODUCTION



One of the country's outstanding authorities on production processes, Mr. R. W. Bolz, has presented in two volumes the actual "keys" to designing for low-cost production. 56 different processes, covering nine big production areas, are comprehensively discussed in terms of design in 924 pages of text, charts and illustrations.

With the emphasis today so pointedly on cost reduction, and with production methods always so important a part of the cost picture, this "shop approach" to design can be your guide to lower costs while products are still in the drawing-board stage. In effect, these two usable encyclopedias of practical information bring production know-how right into the engineering room.

See them **FREE** *on Ten Days Trial.*
Use this handy order form and get your set **NOW!**

THE PENTON PUBLISHING COMPANY, Book Department
1213 West Third St., Cleveland 13, Ohio

Send me both volumes of "Production Processes" by Roger W. Bolz

☐ **On ten days trial for free examination. If the books meet with my approval I will pay $15 (plus tax if any). Otherwise, I will return the books in good condition, postpaid.**

☐ **Remittance enclosed* in which case the books will be sent postpaid.**

☐ **Bill me**

☐ **Bill my company**

☐ **C. O. D.**

Signed ____ **Title** ____

Company ____

Address ____

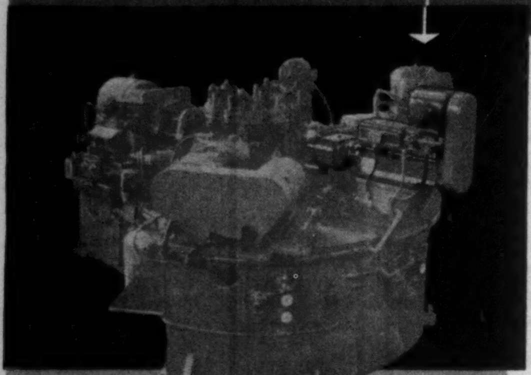
City ____ **Zone** ____ **State** ____

***Please add 45c to cover State Sales Tax on orders for delivery in Ohio.**

New MORRIS AIR·OIL·MATIC DRILL UNITS

air power • hydraulic control or all-hydraulic models

Unit Type Six-station automatic indexing machine for drilling, tapping and facing a master brake cylinder. The Air-Oil-Matic unit shown drills two .026" diameter holes at 10,000 R.P.M. in cast iron.



perfected to give exceptional versatility for higher production at lowest cost

Here's the automatic drilling unit you've been looking for! The Morris AIR-OIL-MATIC Drill Unit is a powerful package of precise versatility developed and perfected by one of the nation's leading manufacturers of high production drilling machinery. Now, this compact unit (air or oil powered and hydraulically controlled) is available for your use in special purpose machines.

Designed for a wide range of drilling, reaming, chamfering, spot facing, hollow milling, centering and related operations, it can be mounted in vertical, angular or horizontal positions. The Morris AIR-OIL-MATIC Drill Unit has adjustable feed rate, feed stroke, total stroke. Controls and actuating devices can be set to provide almost any desired sequence of operations. (see condensed specifications)

If you have mass production operations involving drilling or related operations . . . you'll want to know all about the Morris AIR-OIL-MATIC Drill Unit. New literature describing the unit, its advantages and applications and complete with specifications, is available on request.

CONDENSED SPECIFICATIONS

Length, width, height	33¼" x 11" x 23"
Maximum HP at 1800 rpm	2 HP
Spindle speeds	133-6900 (Standard) (Special speeds on request)
App. maximum thrust	650 lb.
Maximum drill size	⅝"
Maximum stroke	6"
Maximum feed stroke	4½"
Feed rate range	0 to 48"/min.
Quick approach rate	480"/min.
Quick return rate	300"/min.

Morris MACHINE TOOL COMPANY
951 HARRIET ST., CINCINNATI 3, OHIO

new CATALOGS AND LITERATURE

Dual Element Pressure Transducer

Technology Instrument Corp.—Designed to translate static and dynamic air pressures to equivalent voltages, dual element pressure transducer contains two pressure sensitive bellows elements. One element responds to differential between ambient pressure and pressure changes caused by air flow; second element responds directly to the static atmosphere pressure as would an aneroid device. Unit can be used for velocity-altitude-timing computers, recorders, telemeter relaying, systems, servocontrol systems, indicating and display apparatus and alarms. Four-page brochure contains photograph, specifications and diagrams of transducer.

Circle No. 70 on Reply Card

Basic Switch Catalog

Micro Switch Div., Minneapolis-Honeywell Regulator Co.—Ten classifications of line of phenolic enclosed, precision snap action limit switches are described in 28-page catalog. Among switches covered are those with high electrical capacity, high sensitivity, single-pole, double-pole, double break, split contact arrangements, magnetic blow out and sealed construction. Catalog includes photographs, dimensional drawings, terminal variations, electrical ratings and other technical information.

Circle No. 71 on Reply Card

Automatic Metering System

Hetherington & Berner Inc.—Designed for batching light or heavy fluids, fluidometer system is used for metering liquid in gallons, barrels or tank car lots. System consists of three units: control unit, meter and valve. Meter and reset motor are connected with control by means of a direct drive. Eight-page brochure includes diagrams, photographs, applications and list of users of fluidometer.

Circle No. 72 on Reply Card

Starter Layout Plan

"Visual" Plant Layouts Inc.—Designed for companies who want to develop their own three-dimensional planning layouts, starter layout plans help to spread cost outlay over the entire planning cycle. Price list separates the complete plant layout system into its various components. Each group is then priced separately and individually, so that planning equipment may be selected according to budget or model.

Circle No. 73 on Reply Card

Cable Conveyors

Tipp Mfg. Co. — Overhead conveyors with load carrying capacities up to 600 lb per trolley are the subject of a four-page illustrated brochure. Photographs of conveyors carrying stators in a motor plant, acting as pie coolers in a bakery, as a skip lift hoist for scrap handling are among photographs of equipment in application. Among conveyors available are belt and vertical spindle conveyors, floor to floor lifts, conveyorized ovens and metal washer conveying equipment.

Circle No. 74 on Reply Card

Circuit Breakers, Motor Starters

Appleton Electric Co.—Designed for use in refineries, grain elevators, chemical process plants, rubber plants and ordnance plants, circuit breakers and motor starters are discussed in 54-page brochure. Units are explosion-proof, dust and rain tight, and contain no bolts or flanges. Among the models discussed are circuit breakers, line starters, reversing line starters, two-speed line starters and combination line starters. Brochure includes complete specification data on every model, along with photographs, diagrams and applications.

Circle No. 75 on Reply Card

Industrial Television

Farnsworth Electronics Co.—Among features of industrial television system are 600 line resolution, remote optical focusing, and forced draft cooling. System, comprised of a small camera and a monitor interconnected by a multiconductor cable, provides a closed circuit TV chain which will reproduce scenes on which the camera is properly focused. Four-page brochure includes specifications, performance data, accessories and installation information on TV system.

Circle No. 76 on Reply Card

Liquid Filled Temperature Control

Fenwal, Inc. — Liquid filled, local bulb thermostat is the subject of a two-page brochure. Thermostat is designed to provide control of process and oven temperatures at electrical loads up to 15 amp. Unit is adjustable over a range of 70 to 300 F, and —50 to 200 F. Thermostat features an exterior filled bellows assembly, large bellows travel and 1¼-inch spacing between top of bellows and head assembly which provide fast response and accurate control.

Circle No. 77 on Reply Card

Draw Press Bulletin

Clearing Machine Corp.—Twelve-page brochure discusses Clearomatic draw press which is said to have twice the production capacity of other models. Clearomatic can be operated at high, low or combination speeds. Clutch arrangement of the unit allows the driveshaft to be driven at a high or low speed without loss of flywheel energy. Changing from one speed to another is done instantaneously and automatically. Color diagrams and photographs and specification charts are included in the brochure.

Circle No. 78 on Reply Card

Automatic Packaging

Stokes & Smith Co.—Eight-page brochure discusses applications of automatic machinery designed for packaging of a variety of products ranging from foods and drugs to cosmetics. Feed mechanisms to handle liquid, semiliquid, granular and powdered products are illustrated and described along with listings of products being packaged by company machines. Photographs, specifications and operational data on several models are included.

Circle No. 79 on Reply Card

Combustion Control Systems

Hagan Corp.—Use of automatic combustion control systems with various types of gas fired boilers is the subject of a 14-page bulletin. Pictorial diagrams illustrate the application of control equipment as boilers increase in size from a natural draft boiler using a parallel control system to large boilers needing three-element feed water control equipment and interlocking safety devices. Bulletin gives information on combustion control practices for gas-fired steam generators and includes picture-diagrams of components of control systems.

Circle No. 80 on Reply Card

Paint Spraying Equipment

Scientific Electric—Ionic gun and Ionic paint spraying equipment are discussed in eight-page brochure. With this equipment, electrically charged particles of paint are attracted to the article to be painted at ground potential. Among applications of Ionic paint spraying equipment are spraying automobile wheels, oil burner housings, fan blades, sanitary ware, refrigerator components, heater cabinets, etc. Various types of coating materials such as lacquers, enamels, synthetics, varnishes, wrinkles, porcelain enamels, teflon, etc. can be applied with this equipment.

Circle No. 81 on Reply Card

Rack and Panel Connectors

Cannon Electric Co.—Plug in connectors designed for rack or panel chassis in aircraft, computer and transmitter applications are the subject of a 64-page bulletin. General information on the description of parts, selection and ordering of equipment is given, along with specific data on various models of shells, inserts, engaging screws, radio terminal connectors, etc. Bulletin includes exploded views of rack and panel connectors, contact detail, data summaries, mounting area information and wire and assembly data.

Circle No. 82 on Reply Card

Mechanical Shaft Seals

Sealol Corp. — Methods for sealing many types of rotating shafts in the chemical, petroleum and marine fields are described in 12-page catalog. Flexibox seals work on a balanced pressure principle of shaft sealing, where low face-contact pressures in the seal are maintained by a spring drive. Catalog discusses five standard designs which cover a wide range of sealing applications: pressures up to 1000 psi, temperatures up to 450 F, shaft speeds in excess of 3600 rpm and conditions involving corrosive fluids. Catalog also includes photographs, diagrams, applications and specifications of shaft seals.

Circle No. 83 on Reply Card

Electrical and Mechanical Controls

Curtis Development & Mfg. Co.—Four-page brochure entitled "Specialized Development" discusses company line of electrical and mechanical controls and components. Battery charging and discharging cubicles, yard chargers, feeder mechanisms, speed control units, control switches, electronic control assemblies and electrical components such as tapped reactor, solenoid governor assembly, etc. are illustrated.

Circle No. 84 on Reply Card

Limit Type Gages

Sheffield Corp. — Fifty-page catalog gives thorough description of company line of limit type gages. Tabbed sections discuss cylindrical plug gages, taper gages and master setting disks, cylindrical ring gages, adjustable limit gages, thread gages, miscellaneous thread checking equipment, pipe thread gages and engineering data. Each section includes photographs and information on various models, their applications and specifications.

Circle No. 85 on Reply Card

Centrifugal Pumps

Chempump Corp. — Information on sizes, horsepower, heads and capacities, dimensions, materials of construction, design data and construction features is included in 16-page bulletin on centrifugal pumps. Six sealless,

NEW CATALOGS AND LITERATURE

leakproof models are described. Models range from ⅛ to 7½-hp, and are capable of pumping at heads to 195 ft and capacities to 250 gpm. Photographs and diagrams of various models are included.

Circle No. 86 on Reply Card

Pressure Sensitive Tape

Minnesota Mining & Mfg. Co.—Applications of Scotch brand pressure sensitive tape for the metalworking industry are discussed in 56-page catalog. Catalog contains 311 illustrations showing how 47 of more than 300 available tapes can be used by many segments of industry. Catalog is divided into sections covering tape uses for machining and finishing, electroplating, stamping and fabricating, welding, product assembly, painting, product promotion, packaging and shipping, plant maintenance and miscellaneous operations. Other sections cover office uses of tape in automatic, semiautomatic, and manual dispensing equipment, engineering and development services. Photographs of tape in application and a data section covering properties for each of the 47 types are included.

Circle No. 87 on Reply Card

Power Industrial Trucks

Elwell-Parker Electric Co.—Eight-page catalog illustrates company line of power industrial trucks such as fork trucks, high and low lift platform trucks and crane trucks. Each type truck is covered in a separate section with photographs of individual models, operating and design information, and complete specifications. Also illustrated and described are specially designed vehicles—trucks designed to handle automobile bodies where speed is essential, rolls of paper where working area is limited, or hot castings which must be lowered below floor level. Pictures and data on attachments for trucks are also given.

Circle No. 88 on Reply Card

Low Level DC Signal Converter

Magnetic Research Corp.—Photograph, operating characteristics, specifications, performance curves and general information on dc signal converter are included in four-page brochure. Called the "Micromag", converter produces a phase reversing ac output voltage in response to a polarity reversing dc input voltage. Micromag uses no vacuum tubes and has no moving parts. Unit is recommended for low level (microwatt or less) signal detection and amplification.

Circle No. 89 on Reply Card

Hose and Fittings Catalog

Weatherhead Co. — Comprehensive 132-page catalog is devoted to industrial hose and fittings information. Tabbed pages indicate separate sections covering brass tube fittings, drain and shutoff cocks, Ermto steel and stainless steel fittings, bulk hose and reusable ends, and hose assemblies. Section entitled "Technical Data" includes pressure tables, tube bending instructions, correct procedures for making hose assemblies, hose end hex sizes, tubing safety factors, tube wall thickness tables, etc. Additional material on service tools and equipment is given.

Circle No. 90 on Reply Card

Arc Furnace Electrode Control

Askania Regulator Co.—Four-page brochure describes system of hydraulically positioning arc furnace electrodes. Control system reacts instantaneously to any variations in arc impedance. Photographs and diagrams of control system are included in brochure.

Circle No. 91 on Reply Card

Time Recorder and Totalizer

Heat-Timer Corp.—Designed to provide a continuous operation record of any electrically operated machine or process, time recorder and totalizer can be used as an integral part of the equipment, as a remote installation or as a portable tool. Five-page brochure includes photographs, applications and installation information. Equipment operates by means of a chronologically marked tape which continuously moves through the instrument recording the time and length of every on and off period of the machine or process.

Circle No. 92 on Reply Card

Indicators, Recorders, Controllers

Leeds & Northrup Co.—Five sets of data sheets describe company indicators, recorders and controllers which can be used to indicate or record temperature, to provide two-position or proportioning control. Three types of proportioning control: proportional action, position adjusting type or duration adjusting type are discussed. Data sheets have photographs and line drawings illustrating design features, along with specifications and standard ranges for all models.

Circle No. 93 on Reply Card

Pumps and Circulating Systems

Gray Co. Inc.—Powerflo pumps, circulating systems and equipment designed to spray or extrude liquids, semiliquids and semisolids used in production, construction and maintenance are the subject of new catalog. Air operated pumps will handle adhesives, paints, roofing coatings extruded compounds, sealants, waterproofing, sound deadeners, insulation and lubricants.

Circle No. 94 on Reply Card

Annunciator Systems for Industry

Scam Instrument Co.—Six-page brochure contains photographs and specifications of three standard units for self-monitoring control in industry. First unit, plug-in, signals its own failure as well as system defects, and is designed for use with either open or closed field signals. Annunciator cabinets provide for monitoring of a number of functions. Flashers have synchronous motors which give a constant flashing rate regardless of voltage variations and fluctuations in operating temperature. Bulletin also includes a list of standard sequences.

Circle No. 95 on Reply Card

Subminiature Pilot Lights

Dialight Corp.—Four-page brochure contains information on one terminal pilot lights for use on grounded circuits. Five groups of units are described: indicator lights of the nondimming type, dimmer type pilot lights, plastic dome omnidirectional type pilot lights, indicator pilot lights with flat plastic lenses imprinted with numbers or letters, and light shield assemblies for lighting dials and instruments. Photographs of each of the five units, technical data and a dimensional drawing of its parts are included.

Circle No. 96 on Reply Card

Enclosed Conductor Systems

Insul-8-Corp.—Designed for the safety electrification of cranes and monorails, enclosed conductor systems consist of bar conductors, hanger clamps and trolley collectors. Twenty-eight page catalog explains the principles of these insulated systems, and contains an illustrated parts list, engineering data, photographs and sketches of the equipment. Information on the installation and maintenance of enclosed conductor systems is also included.

Circle No. 97 on Reply Card

Strapping Machine

Gerrard Steel Strapping Div., United States Steel Corp.—Strapping machine which is designed for reinforcement, closure and unitizing of corrugated and fiber containers, light box shooks, dimension stock, etc., is the subject of a four-page brochure. Thirteen photographs show machine, Model Q, being used for different applications. Machine uses strapping direct from a continuous coil, thus minimizing waste.

Circle No. 98 on Reply Card

Servomechanism System

Richardson Scale Co.—Newly developed servo system is described in four-page brochure. Components of system are a synchromechanism, control transformer, servoamplifier and servomotor. System is used for non-weighing or general processing applications as well as weighing operations. Brochure lists construction features, and operating characteristics. Also included are photographs and engineering drawings of key parts, along with information on how remote recorders and tape printers may be hooked up and synchronized with servo units.

Circle No. 99 on Reply Card

Roller Gear Drives

Roller Gear Div., Ferguson Machine & Tool Co.—Twenty-page catalog describes line of roller gear drives designed for high speed precision indexing of automatic production machinery. Tables on load ratings and dimensions for components and housed units are given. Also included are data and instructions for calculation of load, designing an installation and selection of a drive.

Circle No. 100 on Reply Card

Conveyor Belts

Cambridge Wire Cloth Co.—Comprehensive 132-page catalog discusses company line of conveyor belts which are designed for conveying in treatment of products in aircraft, automotive, chemical, heat treating, radio, tobacco and other industries. Included in the catalog are photographs of conveyor belts in numerous applications, belt selection charts which give specifications and recommended applications, engineering formulae, conversion tables, and illustrations of company's other products. Alphabetical index provides quick reference to all sections of catalog.

Circle No. 101 on Reply Card

Magnetic Amplifier Systems

Components Div., Federal Telephone & Radio Co.—Magnetic amplifier systems designed for servomechanism, photoelectric, temperature, regulating and motor applications, are the subject of a four-page brochure. Amplifiers feature dependability, long life, small size and suitability for applications where shock and vibration are important factors. Photographs and specifications of several models are included.

Circle No. 102 on Reply Card

Hopper Feeding Headless Set Screws

Set Screw & Mfg. Co.—New mechanism mechanically feeds set screws from a vibrating hopper, down through a tube, and then automatically positions them for driving. Mechanism consists of vibrating hopper, roller device which puts screws right side up, and tube which feeds screws to the job, correctly positioned for driving. Bound, four-page brochure discusses features of mechanism—automatic diameter inspection and rejection of misfits—and includes photographs of machine in application.

Circle No. 103 on Reply Card

High Speed Index Tables

Roller Gear Div., Ferguson Machine & Tool Co.—Precision index tables for high speed production are discussed in 12-page brochure. Assembly drawings, tables of load ratings and dimensions of more than 150 models are included in the brochure. Data on the indexing mechanism, roller gear drive and multiple station transfer machine are also covered.

Circle No. 104 on Reply Card

Purchasing Power Supplies

New Jersey Electronics Corp.—Majority of conventional regulated power supply applications are standardized into single and multiple variations of eight basic ranges, arising out of two basic circuit designs. Eight-page brochure includes electrical, mechanical and construc-

NEW CATALOGS

tional specifications for each power supply, along with price, delivery, packaging and shipping data. Brochure is said to simplify selection and purchasing of regulated power supplies.

Circle No. 105 on Reply Card

Controlled Capacity Pumps

Philadelphia Pump & Machinery Co. — Standard pumps (up to 1500 psi) and low pressure pumps (up to 800 psi) are described in catalog. Control mechanisms which vary the pump capacity by varying the stroke length of reciprocating pumps while in motion are also covered. Control devices proportion pump capacity in relation to temperature, flow, pH value, liquid level, pressure, conductivity or any other meterable factor in response to manual, hydraulic, pneumatic or electrical motivation.

Circle No. 106 on Reply Card

Hydraulic Control Manifolds

Almo Tool Co.—Applications and operation of hydraulic circuit control manifolds are discussed in four-page brochure. Manifolds are designed for use in broaching, grinding, forming, molding, drilling and boring machines. Units consist of a series of steel plates in which routed channels are used to direct flow of hydraulic fluid. Brochure includes photographs of manifolds and a typical hydraulic circuit blueprint.

Circle No. 107 on Reply Card

Conveyor Catalog

Logan Co. Inc.—Complete information on company conveyors is included in 34-page catalog. Among categories covered are ball transfers, belt and roller conveyors, lifts, roller spirals, etc. Sections on lifts and roller conveyors are subdivided into various models and their applications. Numerous photographs illustrate equipment in application, and index by industries directs reader to section applicable to his interests.

Circle No. 108 on Reply Card

Electric Motor Controls

Furnas Electric Co. — Pocket size booklet contains 46 pages of information, photographs, specifications and prices on motor controls. Magnetic, combination and reversing starters, magnetic and reversing contactors, pushbuttons, limit switches, drum controls, and heater coil tables are among the items covered.

Circle No. 109 on Reply Card

Finishing Systems

Spra-Con Co.—Forty-page catalog provides basic technical information on engineering of finishing systems. Conveyors, washers, dry-off ovens, bake ovens, spray booths, paint applicators, and air supplies are among the finishing equipment discussed. Catalog includes photographs of equipment in application, specifications and blueprints of various machines.

Circle No. 110 on Reply Card

Automatic Production Machine

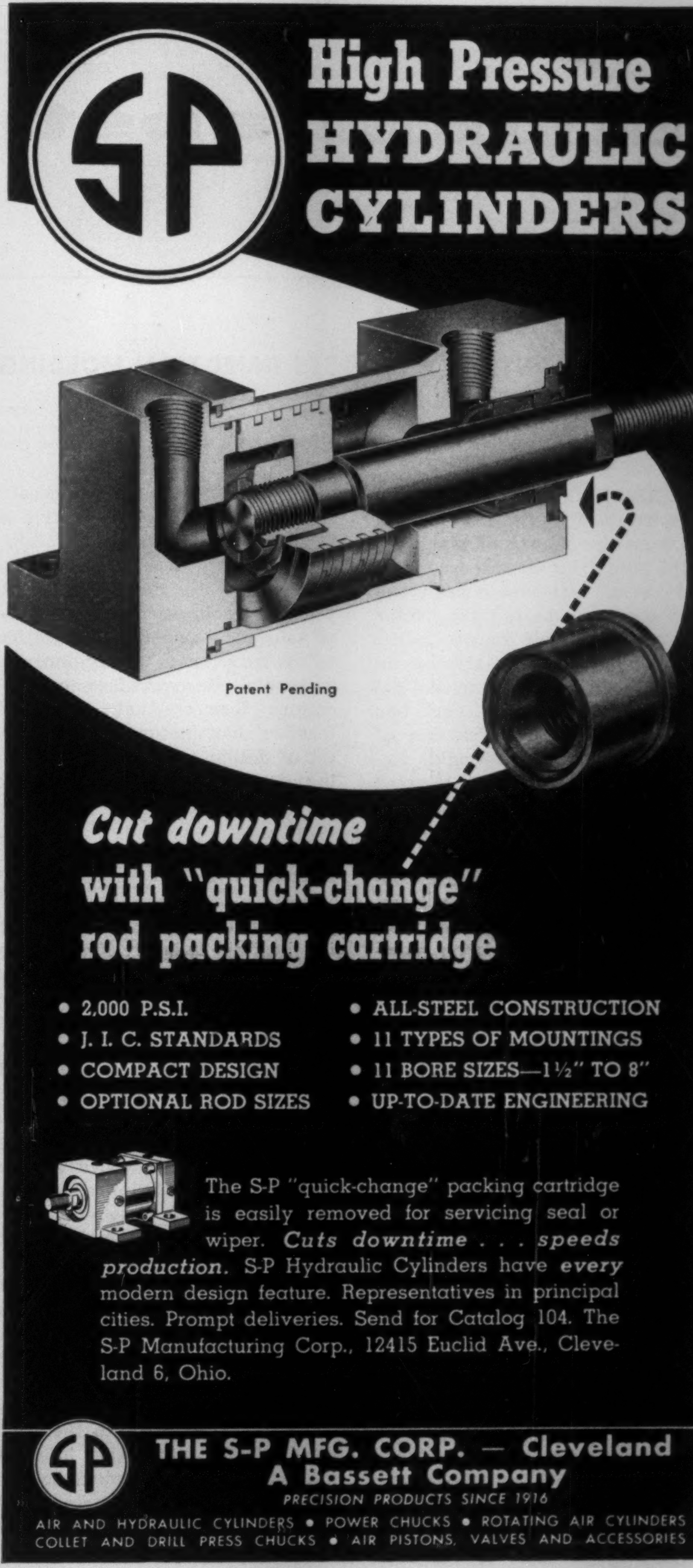
Ketchpel Engineering Co. Inc. — Air and electrically operated machine is adaptable for small drilling, turning, and punching operations. Production rates of 40 to 65 pieces per minute are possible with an integrated 12-station feed table. Photographs of machine are included in brochure.

Circle No. 111 on Reply Card

Automatic Press Room Equipment

U. S. Tool Co. Inc.—Eighteen-page brochure discusses slide and roll feeds, straighteners, stock reels, coil cradles and other automatic press room equipment. Information in the brochure includes methods of operation, ordering and selection data, sizes and specifications of different models. Also given are photographs of equipment in operation.

Circle No. 112 on Reply Card



High Pressure
HYDRAULIC
CYLINDERS

Cut downtime
with "quick-change"
rod packing cartridge

- 2,000 P.S.I.
- J. I. C. STANDARDS
- COMPACT DESIGN
- OPTIONAL ROD SIZES
- ALL-STEEL CONSTRUCTION
- 11 TYPES OF MOUNTINGS
- 11 BORE SIZES—1½" TO 8"
- UP-TO-DATE ENGINEERING

The S-P "quick-change" packing cartridge is easily removed for servicing seal or wiper. ***Cuts downtime . . . speeds production.*** S-P Hydraulic Cylinders have ***every*** modern design feature. Representatives in principal cities. Prompt deliveries. Send for Catalog 104. The S-P Manufacturing Corp., 12415 Euclid Ave., Cleveland 6, Ohio.

THE S-P MFG. CORP. — Cleveland
A Bassett Company
PRECISION PRODUCTS SINCE 1916
AIR AND HYDRAULIC CYLINDERS • POWER CHUCKS • ROTATING AIR CYLINDERS
COLLET AND DRILL PRESS CHUCKS • AIR PISTONS, VALVES AND ACCESSORIES

AUTOMATION abstracts

PRESSURE CONTROL ADVANCES INJECTION MOLDING

By G. B. THAYER
Dow Chemical Co.
Midland, Mich.

PRECISION CONTROL of plastic pressure during injection molding has been the subject of much detailed study during the past several years. Pressure control has been shown to be the key factor in controlling mold release forces and inherent molding stresses in the finished part. Dimensional accuracy of the finished part has been shown to be a function of pressure control in the mold. Resistance to distortion at elevated temperatures has been accepted as a function of pressure control inside the mold.

Several means of pressure control have been employed by injection molders. Temperature, pressure, and time controls on molding machines provide relatively wide latitude for this purpose. Balanced gate resistance, flow control within the cavities, mold temperature controllers, restricted gates, ball-check nozzles, and weighed-starved feeding of the molding granules have been employed individually and in systematic combinations to control the plastic pressure. These principles and mechanical devices have been highly successful in improving the quality of injection-molded articles and in decreasing the cost of the molding operations.

It has become well established that the most effective and precise means of controlling pressure in the mold is to place the exact weight of plastic there as quickly as possible. Weighed-starved feeding of conventional injection molding machines has been effective in placing the correct weight of granules in the mold. Preplasticizing has been highly effective in filling the mold quickly.

These two technical developments have accomplished much progress in broadening the range of safe and economical application of thermoplastics as engineering materials. Success of some applications formerly not considered feasible has aroused the interest of design engineers in expanding the use of thermoplastics to new fields.

Injection Cycle

A conventional injection-molding heating cylinder, *Fig.* 1, may be described as one which receives a charge of cold granules at one end and delivers a charge of melted plastic from the other end into the runner system of the mold. Immediately in front of the injection plunger, upon completing its forward stroke, there is a region of packed granules which extends some indefinite distance forward into the heating cylinder. These granules are increasingly softer and more nearly melted toward the nozzle end of the heating cylinder as indicated by the diagram.

The principle of weighed-starved feeding is to place the correct amount of plastic granules in front of the injection plunger and push them forward into the heating cylinder until the injection piston can move forward no farther, because it is in contact with the front hydraulic cylinder head. With this means of operation, it is possible to hold the plastic in the mold until the gate has solidified sufficiently to prevent discharge of plastic from the mold. If a cushion of plastic granules remains ahead of the injection plunger after the mold is full, the hydraulic pressure in the oil cylinder is capable of forcing more plastic into the mold during the next few seconds, and this causes packing which results in high residual stress in the molded piece.

The operation of weighing the charge of molding granules is subject to some lack of precision. No weighing device at present can measure the exact weight at each cycle of weighing. The inaccuracy is usually cumulative, and sooner or later the molding operation departs too far from equilibrium. The heating cylinder will gradually build up a cushion of granules which stops the plunger before it completes its full stroke if the weight of the charge is slightly heavy. Conversely the heating cylinder gradually will be starved until short unfilled parts result if the weight is slightly too light.

Compensation for the weight of the charge should be based on the pressure which exists in the fluid plastic at the instant the hydraulic piston reaches the front cylinder head. This bases the control of the molding system upon plastic pressure which is the basic factor to be controlled. Self-compensating weighers have been proposed and can be effective in overcoming inherent inaccuracies.

When weighed-starved feeding is employed, the injection plunger must stop its forward motion at a fixed position upon completion of each stroke, restrained by the front hydraulic cylinder head. The plunger is relatively rigid, but the plastic between the end of the plunger and the gate of the mold is compressible. The compressibility of the plastic portion of the plunger system, *Fig.* 2, can introduce much more inaccuracy in a weighed-starved feeding system than does the weigh-feeding machine.

The front end of the plunger transmits pressure through the packed granules and through the fluid plastic into the heating cylinder and runner system into the mold. The fluid plastic is compressed to some extent, perhaps 4 to 7 per cent, after the plunger reaches its forward position with the mold closed.

A plug of packed granules acts as an extension of the plunger and transmits pressure to the fluid plastic. The rigidity of this plug of granules can vary because of several factors. Temperature of the granules is one factor which helps determine their ability to push the fluid charge forward. If the granules are hot, they crush together readily and shorten the effective length of the plunger. Furthermore, if the granules are well lubricated externally, they slip past each other more easily. Size and shape of the granules have a similar effect.

Difference in the effective length of the plunger due to variation in compression of the fluid plastic probably is a considerably lesser factor than the variation of the plug of cold granules. Compression of the fluid plastic is not negligible, however. These variations in compressibility of the plunger system can be compensated if the control is based upon the pressure of the fluid plastic in the nozzle of the molding machine. It has not been simple to install a pressure-control device at this point because of space limitations. A pressure-limit switch is needed to perform the control signaling at this point.

Preplasticizing

Recent experience with preplasticizing machines which employ a heating chamber of some kind to introduce fluid plastic into a transfer or injection chamber has indi-

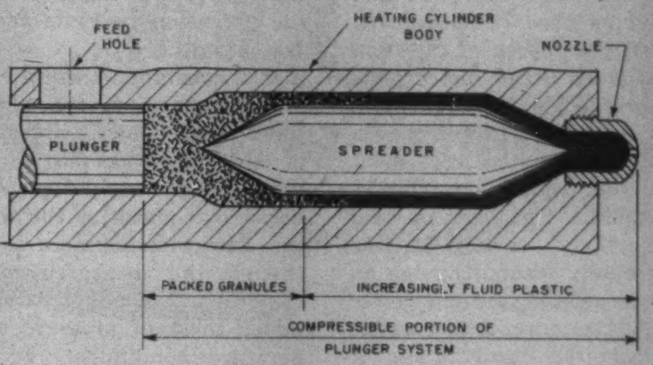

FEED HOLE
HEATING CYLINDER BODY
NOZZLE
PLUNGER
SPREADER
PACKED GRANULES
INCREASINGLY FLUID PLASTIC
COMPRESSIBLE PORTION OF PLUNGER SYSTEM

Fig. 1—Schematic diagram of a conventional heating cylinder which receives a charge of cold granules at one end and delivers a charge of melted plastic into the runner system of the mold. Granules approach the liquid state increasingly toward the nozzle end of the heating cylinder

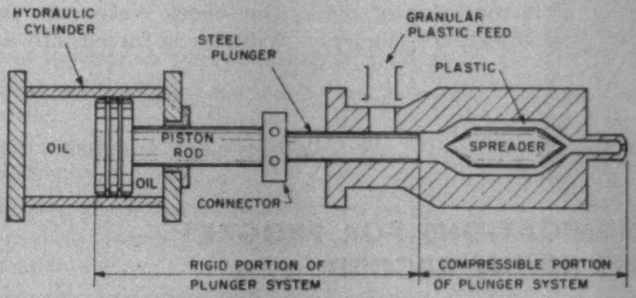

HYDRAULIC CYLINDER
STEEL PLUNGER
GRANULAR PLASTIC FEED
PLASTIC
OIL
PISTON ROD
OIL
SPREADER
CONNECTOR
RIGID PORTION OF PLUNGER SYSTEM
COMPRESSIBLE PORTION OF PLUNGER SYSTEM

Fig. 2—Complete plunger system showing the rigid and compressible portions. Difference in the effective length of the plunger due to variation in compression of fluid plastic is not as critical a factor as variation of the plug of cold granules

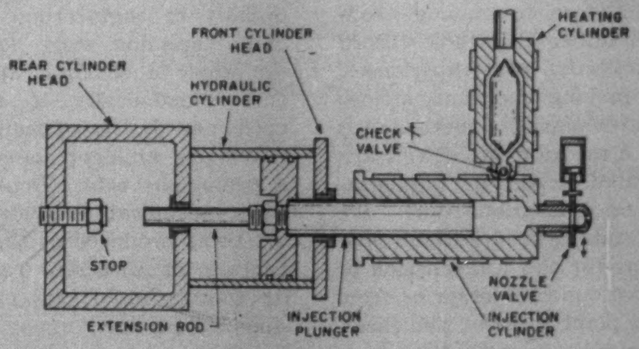

HEATING CYLINDER
FRONT CYLINDER HEAD
REAR CYLINDER HEAD
HYDRAULIC CYLINDER
CHECK VALVE
STOP
NOZZLE VALVE
EXTENSION ROD
INJECTION PLUNGER
INJECTION CYLINDER

Fig. 3—Preplasticizing system in which fluid plastic is introduced into the injection cylinder. Some molding systems employ a receiving chamber which receives the melted plastic from the heating cylinder and then dumps the charge into the injection cylinder. This allows better pressure control in both the receiving and injection chambers

cated there is considerable advantage in this technique. High injection speed can be obtained and molds can be filled in one second or less. Higher speed of injection results in much better distribution of pressure inside the mold, and there is much less difference in pressure between the region at the gate and remote extremities of the mold. The conventional heating cylinder cannot fill the mold as rapidly without having an excessively large hydraulic power plant. Furthermore, it is possible to overcome the disadvantage of compressibility of the plunger system which is brought about by the packed granules.

In a preplasticizing system, *Fig.* 3, the fluid plastic is introduced in front of the injection plunger and pushes it back as the plastic enters, minimizing the introduction of air into the molten plastic. At the time of introduction of the plastic into the injection cylinder, the nozzle valve is in the closed position. The fluid plastic forces the hydraulic piston back until the extension rod hits the preadjusted stop.

If a constant pressure condition is maintained on the plunger of the heating cylinder and it in turn is able to transmit a constant pressure to the fluid plastic, it is possible to measure the weight of the charge rather accurately even though the measurement is actually by volume of fluid plastic under constant pressure and temperature conditions. It appears from present experience this is a feasible and simple method of introducing greater precision into the injection-molding process.

The injection plunger moves forward until the hydraulic piston comes in contact with the front cylinder head. During this time the nozzle valve must be open and the check valve on the heating cylinder is forced into a closed position to prevent back flow of the fluid plastic into the heating cylinder. The plunger may be held in the forward position until the gate has solidified sufficiently to prevent plastic discharge from the mold, or the plunger may be withdrawn immediately while the nozzle valve is closed simultaneously.

Greater precision in the control of injection molding pressure can be obtained most readily by recognizing the major problems and dealing with them first. Careful attention to uniform molding cycles can provide better precision without automatic compensation. Automatic compensation requires more dependable equipment and more uniform molding cycles to be effective.

From a paper entitled, "Precision Control of Injection-Molding Pressure" presented at the Annual Meeting of ASME in New York, Nov.-Dec., 1954.

COMMUNICATIONS FOR PROGRESS—WHAT'S IN THE RECORD

V. BUSH
Carnegie Institution of Washington
Washington, D. C.

PROGRESS of our civilization in peacetime depends, and has always depended, not only on our current thoughts and findings, but on the skill and facility with which we create, store, interchange, consult, and utilize the whole record of our collective past experiences. We are making enormous strides in the development of methods for creating a record of what we learn —in printed words, by photography, or on a magnetic tape. We are also making strides in developing means for the transmission of ideas from one to another or from a central point to great audiences.

But in one exceedingly important phase of the whole problem we are making little progress indeed. This is the phase of finding in the record the information that we need. If the record of our experience is to serve us well, we need to be able to extract from it at will, promptly and inexpensively, any single item of current moment. This is of great importance for the progress of science, but it is also important in every professional field of activity and especially in engineering, which is daily becoming more complex in the ways in which it applies science economically to meet the needs and desires of mankind.

We are building the record at a prodigious rate. Books, magazines, technical journals, reports are being produced by the ton. The Library of Congress reported in its *Quarterly Journal of Current Acquisitions* for August 1954 that in fields of science, technology, medicine, and agriculture it received approximately 30,000 journals including 2000 new titles; 25,000 research reports; 15,000 books and monographs; 15,000 manuscripts; 10,000 pamphlets; 5000 prints, blueprints, microfilms, etc.; and 150,000 maps and charts.

Our libraries are filled to overflowing, and their growth is exponential. Yet in this vast and ever-increasing store of information we still hunt for particular items by horse and buggy methods. As a result there is much duplication and repetition of research. We are being smothered in our own product. While we record with great care the work of thousands of able and devoted men, full of significance and timeliness to others, a large and increasing fraction of their work is, for all essential purposes, lost simply because we do not know how to find a pertinent item of information after it has become embedded in the mass.

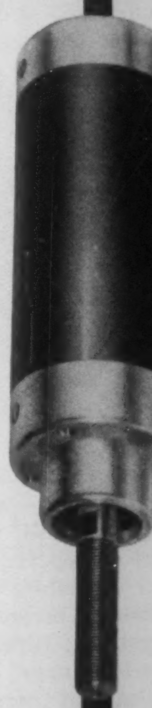
Who Can Do It

The problem is not essentially one of techniques. It is rather one of deciding who is to do the job of clearing up the confusion and under what auspices. There are plenty of good techniques available. Recently I participated in a study of how mechanization could be applied to the problem of searching in the Patent Office, where millions of items need to be scanned for equivalents of the combinations presented in patent applications. This study showed that there are at least 50 companies active in the production of one kind or another of data-handling equipment. I have not time to review all the ingenious devices now being used for commercial purposes by banks, insurance companies, and other businesses, or for scientific computation and analysis in hundreds of fields of research. It is sufficient to say that there are several ways in which items can be scanned at the rate of a thousand a second, selected in accordance with a complex code, and reproduced automatically.

Photographic methods can reduce the size of a record by a factor of 100 to one or more, and re-enlarge on call with negligible loss of legibility, thus cramming the material of a thousand books into the space of a cigarette package. Digital computing devices can manipulate records in the form of numbers at the rate of a million operations a second if necessary. Magnetic tape can receive any kind of data, combine them, and reproduce them at will; and it lends itself to ready erasure, replacement, and rearrangement. There is no lack of powerful, versatile equipment, which is quite capable of rendering our stored records available in prompt, accurate, effective fashion, and at a distance if this is desired.

Experimentation Needed

But to code our scientific literature or our legal documents or any other part of our mounting records and thus to place them under the control of machinery responsive to our will is a stupendous undertaking. Worse than that, it is everyone's business and the assigned responsibility of no one group in particular. There is not the slightest doubt that it would pay, in a very practical sense, to do the job no matter how seemingly great the cost. It would pay everyone, and the expense should therefore be borne by everyone. Thus it is a task for gov-



NEW NP
Power Drive Cylinder
. . . has all the "most wanted" design features

No other cylinder offers you so many vital features: compact, streamlined design; lightweight aluminum alloy and steel construction exceeds all strength requirements; interchangeable mountings — foot, flange, pivot, clevis and trunnion. Every cylinder can *operate with air, water or oil without interchanging or adding parts:* Adjustable cushioning (optional) can be added to any cylinder at any time.

PLUS

1. Sealed-in lubrication eliminates line lubricators.
2. Rod wiper and long, self-lubricating bronze rod bearing.
3. Self-compensating synthetic multiple "V" rod packing.
4. Rod packing and bearing externally removable.
5. Large porting gives quick response and smooth performance.
6. Rotatable end caps allow 360° piping location.
7. Rust-proofed cylinder tubing has tough I.D. surface.
8. Bronze piston bearing assures maximum support.
9. Ground and polished stainless steel piston rod.
10. Synthetic "U" cups automatically adjust for wear.

Mail this coupon for data sheets
INDUSTRIAL ACTUATORS AND CONTROLS DIVISION,
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston 19, Mass.

GENTLEMEN: Please send me complete information on
☐ NP Power Drive Cylinder ☐ NP Power Check feed control
☐ NP Power Trol valves

*Name*__________ *Title*__________
*Company*__________
*Street*__________
*City*__________ *Zone*_____ *State*_____

NATIONAL PNEUMATIC CO., INC. AND **HOLTZER-CABOT** DIVISIONS

125 Amory St., Boston 19, Mass.
Sales Service Representatives
in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

ernment.

But is it possible for a government which cannot even mechanize its postal system to be farsighted and courageous enough to undertake a task of such complexity and such magnitude? Probably not. The methods to be adopted, moreover, are not at all clear at the moment. The whole art of data handling is improving every day, and it would be a mistake to freeze upon a single system prematurely. So it probably would not be wise to plunge in at once and undertake a comprehensive and expensive program for, to use an example, the entire bulk of scientific literature. The various possible approaches need rather to be tried out on a more modest scale. The time has most certainly arrived when special sections of the record can be subjected to mechanization with genuine benefit to those who use them.

Looking forward, I am confident that we shall see further advances, most interesting ones, throughout the whole range of devices by which man communicates with his fellows. And as a result I believe we shall, as a race, if we do not commit suicide by indulging in total war, advance in knowledge and understanding and perhaps also in wisdom. I believe we shall advance in our mastery over the records we create, rendering them easier to consult by means which would now seem strange and bizarre to us, which will make obsolete much of what we now do, but which will give a new power and freedom to the creative mind and thereby open the way for another spurt forward of civilization. For civilization advances only as it acquires new experience and only as it makes its experience available and useful.

From an address entitled "Communications — Where Do We Go From Here?" presented at the Founding Anniversary Meeting of ASME in New York, Feb., 1955.

ENGINEERS AND AUTOMATION

By R. H. SULLIVAN
Ford Motor Co.
Detroit, Mich.

MANY OF YOU must be wondering about the role of the engineer in automation—what this new development will mean to you in terms of opportunity and job content. I hesitate to make any flat predictions because it's a field that is changing rapidly and will continue to change, I'm sure, as time goes on. But there are a few points on which I think I can speak with a great deal of certainty.

It should be clear, for one thing, that automation will intensify the demand for engineers—and for many different kinds of engineering skills. It's no news to any of you that demand has been way ahead of supply for a number of years now, insofar as engineers are concerned. This will become even more of a problem in the years ahead unless we can somehow manage to increase the number of graduates from our engineering schools.

The marvelous, complex automation devices were designed and created for the most part by engineers, and we shall need a great many more men with similar training to maintain those devices and to improve upon them as time goes on. What we need, in effect, are engineers who are also "imagineers"—men who can translate the concept or philosophy of automation into practical, working applications. We still have a lot to learn about this thing called automation, and we look to our engineers to help us make progress.

Broadened Specialists

There are a great many problems to be solved by engineers if we are to keep advancing in this area. Production lines have to be rebalanced to take into account the increased rate of production of automated units. Better gaging and inspection equipment is needed to guard against oversize parts and broken tools. We need better quality control methods aimed at preventing faulty production rather than detecting it at the end of the line. We need better tool changing and repair methods, better communication systems between operators and supervisors on the line, and so on through a long list. As you can see, automation opens a whole new market for engineering skills.

Another effect of automation will undoubtedly be to cause greater specialization among engineers in manufacturing concerns. The more complex our production lines and automation devices become, the more necessary it will be for each and every element of the manufacturing process to be thoroughly thought out and carefully planned in advance. Instead of being given an entire project to handle, the engineer may be assigned one small but highly important part of the project to analyze, develop and integrate with other equally important parts of the overall process.

At the same time that he is specializing, however, the engineer will be expected to co-operate effectively with other specialists in other parts of the plant. More than ever, it will be necessary to have good teamwork among tool and die designers, plant layout men, automation layout specialists, the machine tool builders and many others—including accountants and industrial relations experts. It is important that all phases of production planning be fully co-ordinated at the very beginning of a project and that this co-ordination be maintained without interruption.

It will be necessary for even the most highly specialized engineering groups to understand and appreciate the problems of the other departments. The engineer will have to be concerned with the "big picture" as well as with his own immediate problems. What goes on in another department may have a very direct bearing on the success of his own operation, and his work, in turn, might have to be adjusted to prevent possible trouble at a later stage in the process. In other words, the more the engineer knows about the overall project, the more intelligently and effectively he can handle his own particular phase of the job.

Upgrading Engineers

What's more, with a whole labor force being upgraded in technical skills, it will become increasingly necessary, I think, for the engineer to take on more managerial responsibilities. As highly trained employees become more and more competent in the handling of automation equipment, it should be possible for the engineer to extend his special knowledge and skill through the minds and hands of others. With so many technicians and highly skilled workers available for detailed tasks, the engineer should be free to make full use of his valuable training where it will do the most good—in broad planning and development of new ideas and in the application of those ideas to current problems.

And finally, I believe it will be necessary for the engineer to give more thought and attention to the broad human and social values of our time. The increase in human knowledge over the past several decades has been prodigious, and every day brings us still greater knowledge. But our economic and social well-being depends in large part on our ability and willingness to make that knowledge serve mankind. There is the great challenge to the engineer.

Automation is more than a manufacturing method or an economic necessity. It is a magic key to creation—to a better life for all of us. Like the atom, its potential is unlimited. But we must learn to understand it, control it and direct it into avenues of increasing human betterment. As we make our way toward that goal, it is the engineer who must spearhead our advance.

From an address presented at the Annual Meeting of the Cleveland Society of Professional Engineers in Cleveland, Jan., 1955.

ATTENTION
All Process Machine Engineers

SIMPLIFY YOUR MACHINES AND REDUCE YOUR COSTS BY ADOPTING TIME OR COUNT CONTROL DEVICES.

Machine operators prefer dial control with automatic operation for those tedious jobs. Repetitive performance with assured quality control is guaranteed.

Eagle Signal Corporation can supply a precision timer or counter for any purpose or they can design and build a control panel assembly for your application. Let Eagle engineers assist you with your machine control problem.

Write for **FREE BOOKLET**
"See What Timing Can Do For You"

Industrial Timers by EAGLE

EAGLE SIGNAL
CORPORATION
MOLINE, ILL.

Eagle Timers save time, save money.

PEOPLE ARE NEEDED IN DATA PROCESSING

By T. Y. HICKS, IBM, Houston, Tex.
G. V. ROHLEDER, Service Pipe Line Co., Tulsa, Okla.

OUR WORLD of rapidly expanding research and production demands better and faster answers to more and bigger problems. As a result, the need for improved methods of solution has led to the use of mathematical techniques which often require the processing of much data.

Today problems can be solved which would have been considered impossible a few years ago. Although the method of solution may have been known for years, the many calculations required, in some cases billions, prevented obtaining an answer. Further, we are now able to solve many problems with less effort and expense while achieving greater speed and accuracy than before.

Electronic digital computing equipment has made these solutions possible. Computers are manufactured in many sizes, all of which have highly flexible applications. These machines process data in a variety of ways from routine accounting problems to complex scientific problems. Thousands of electronic calculators produced by various manufacturers are installed throughout the country and are processing all kinds of data.

Digital Computers

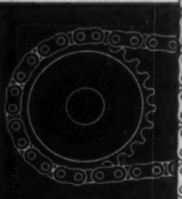
Basically, all digital computers have five components: input, storage, arithmetic, control and output. Information is read into the machine through the input components usually from punched cards or from tapes (magnetic or paper).

It is necessary to store this information before calculation so it may be called on as needed during the calculation. It is sometimes necessary to store intermediate results for further calculation and in any case the answer or output information must be stored at least temporarily. There are many storage devices in use today, some of which have been previously mentioned, and many others are being investigated in the research laboratories.

The arithmetic unit in a machine performs all mathematical and logical operations. The control unit links the other components together and causes the computer to function as a co-ordinated piece of equipment. Several types of output are possible depending, of course, on the equipment used. Usually the output information is printed, punched in cards, read

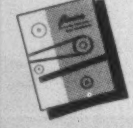
POSITIVE MOTION TRANSFER
with . . . no cable slippage
. . . no complicated gearing

SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS



The ideal way to provide precise, positive control in servo systems, gyro systems, special cameras, small precision instruments, and many other miniature and sub-miniature assemblies. Transmits power through several planes simultaneously. Unlimited center-to-center selection. Reduces weight, cost, maintenance. Permits wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

123 E. Montecito Avenue,
Sierra Madre, California

Sierra ENGINEERING CO.

T. M. REG.

EVERY ENGINEER will want a copy of this BULLETIN

HANNIFIN
FLUID POWER CYLINDERS
HANNIFIN CORPORATION

WRITE FOR BULLETIN 213. Complete details and mounting dimensions on Hannifin Series "A" Square Type Fluid Power Cylinders, usable up to 200 psi, air or oil. This is the cylinder with the new, externally removable cartridge gland...the biggest improvement in cylinder design in the last 50 years. The "A" line is complete! 11 bore sizes from 1½" to 14"—13 standard mountings, many combinations. Steel heads. Brass bodies. Piston rods ground, polished and hard chrome plated. Send for Bulletin 213. It's the easiest catalog to use in the cylinder business.

HANNIFIN

Hannifin Corporation, 541 S. Wolf Road, Des Plaines, Ill.
Air and Hydraulic Cylinders • Presses • Air Control Valves

onto tapes, or stored in the machine for further use.

Actually, a computer can be programmed to perform any operation which can be done manually with pencil and paper. In other words, if the method employed in solving any problem can be written down in concise and logical steps, a machine can be programmed to perform the solution. This suggests the very important point that a machine can do nothing it is not instructed to do.

To elaborate, a computer can add, subtract, multiply, divide, and make comparative decisions. This enables a machine to perform a multitude of tasks. Just to list a few, a machine can be used to extract roots, evaluate formulas, solve algebraic and transcendental equations, solve systems of algebraic equations, evaluate analytic functions, sum series, evaluate integrals, solve differential equations, invert matrices.

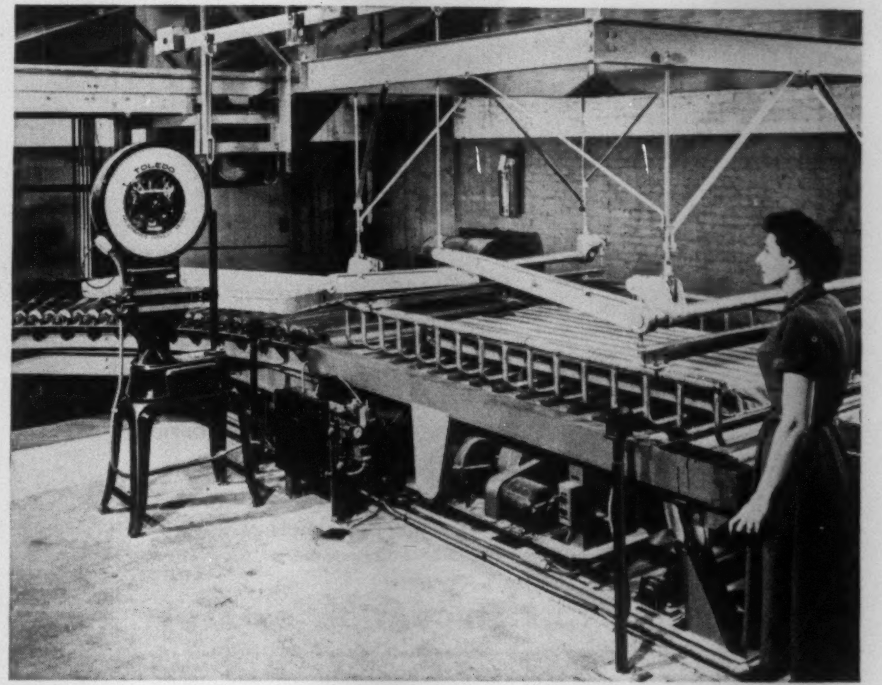
Economics of Application

This means then that an electronic computer can be applied to almost any type of problem anywhere. Of course, all problems are not good machine applications. If a problem is to be solved only once, how does the time and expense of preparing it for machine solution compare with the manual solution? What about the urgency for solution? How important is speed and accuracy? If the problem is small, how many times do we want to solve it? Some very small problems can be excellent machine applications. Actually, there are many considerations in determining whether or not a particular problem is a good machine application or if a machine installation is justified.

Electronic computing equipment can solve problems heretofore impossible because of the large number of calculations required or it can solve problems that are difficult or tedious by any other method. Machine computation can often suggest other methods of approach.

Usually, the accounting department already has an installation with some machine time that can be made available to other depart-

THE PRODUCT "WEIGHS OUT" AUTOMATICALLY



Finished products ride a powered conveyor to the shipping department in this MHS designed and built automated foam rubber plant. As each mattress or pad rolls onto the special section (right, above), the conveyor stops, the rollers fall away to leave the product in a weighing cradle. The scale weighs the product, records its weight on a tape, the rollers rise and the conveyor starts again.

This special system of automatic weighing ties in with the automatic production system from raw latex to finished foam products. The complete printed record of finished product weight is obtained as fast as production flows. Total finished product weight compared with raw materials weight measures plant efficiency accurately.

MHS engineers are remarkably proficient in working out practical solutions in automatic handling and automatic production. A letter or call will put them to work for you to bring the advantages of automation to your manufacturing.

Mechanical Handling Systems Inc.

MHS

AND SUBSIDIARIES

4632 Nancy Ave., Detroit 12, Michigan

Offices in Principal Cities

FACTORIES: Detroit, Mich. • Fairfield, Iowa • Albany, N.Y. • Windsor, Ontario